DOCUMENT RESUME

ED 129 565	SE 019 499
TITLE	Physics in Perspective Volume II, Part C, Statistical Data.
INSTITUTION	National Academy of Sciences - National Research Council, Washington, D.C. Physics Survey Committee.d
PUB DATE	73
NOTE	326p.; For Volume I of this series, see ED082942; Not available in hard copy due to numerous small print and marginal legibility of original document
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	Economic Factors; *Financial Support; Graduate Study; *Higher Education; *Manpower Needs; Manpower Utilization; *Physics; *Research; Science Education; *Statistical Data

ABSTRACT

Statistical data relating to the sociology and economics of the physics enterprise are presented and explained. The data are divided into three sections: manpower data, data on funding and costs, and data on the literature of physics. Each section includes numerous studies, with notes on the sources and types of data, gathering procedures, and interpretations. Additional explanatory notes are found in the appendices, such as questionnaire samples, term definitions, and a list of physics subfields. (MH)

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PHYSICS IN PERSPECTIVE

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VOLUME II
PART C

Statistical Data

Summary Material
Collected by the Staff
and Some Members of
the Data Panel

SE 019 499

2

NATIONAL
ACADEMY of
SCIENCES

PHYSICS IN PERSPECTIVE

VOLUME II
PART C

Statistical Data

Auxiliary Material
Collected by the Staff
and Some Members of
the Data Panel

Physics Survey Committee • National Research Council

NATIONAL ACADEMY OF SCIENCES Washington, D.C. 1973

NOTICE: The study reported herein was undertaken under the aegis of the Committee on Science and Public Policy (COSPUP) of the National Academy of Sciences–National Research Council, with the express approval of the Governing Board of the National Research Council.

Responsibility for all aspects of this report rests with the Physics Survey Committee, to whom sincere appreciation is here expressed.

The report has not been submitted for approval to the Academy membership or to the Council but, in accordance with Academy procedures, has been reviewed and approved by the Committee on Science and Public Policy. It is being distributed, following this review, with the approval of the President of the Academy.

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National Research Council. Physics Survey Committee.
Physics in perspective.

"Undertaken under the aegis of the Committee on Science and Public Policy of the National Academy of Sciences—National Research Council."
Includes bibliographical references.
PARTIAL CONTENTS: v. 2. pt. A. The core subfields of physics.—v. 2. pt. B. The interfaces.
1. Physics—Research—United States. 2. Science—United States.—v. 2. pt. C. Statistical Data.
I. National Research Council. Committee on Science and Public Policy. II. Title.
QC9.U5N28 530'.0973 72-84752
ISBN 0-309-02101-4

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PREFACE

The Physics Survey Committee was appointed by the President of the National Academy of Sciences in mid-1969 to survey the status, opportunities, and problems of physics in the United States. Volume I of *Physics in Perspective* constitutes the full report of the Committee. This and the companion parts of Volume II, complete the report of the survey.

The Survey Committee early concluded that it was essential that it obtain detailed information from experts in each of a number of physics subfields and interface areas. For each of these subfields and interface areas a chairman was appointed by the Chairman of the Survey Committee, and groups of recognized experts were brought together to survey and report on their respective subject areas.

Several of the subfields have relatively well-defined and traditional boundaries in physics. Included are the core subfields of acoustics, optics, condensed matter, plasmas and fluids, atomic, molecular, and electron physics, nuclear physics and elementary-particle physics. The reports of these panels constitute Part A of Volume II. In addition, there are several important interface areas between physics and other sciences. These are examined in Part B of Volume II. In the case of astronomy, where activity is particularly vigorous at the interface and is overlapping, the Physics and Astronomy Survey Committees agreed to form a joint panel that would report on astrophysics and relativity, an area of special interest to both. The broad area in which physics overlaps geology, oceanography, terrestrial and planetary atmospheric studies, and other environmental sciences was defined as earth and planetary physics, and a panel was established to survey it. In covering the physics-chemistry and physics-biology interfaces, the broader designations "physics in chemistry" and "physics in biology" were chosen to avoid restricting the work of the panels to the already traditional boundaries of these interdisciplinary fields.

Although each panel--and particularly those responsible for the core subfields--was asked to consider the interaction of its subfield with technology, the Committee anticipated that the emphasis would be on recent developments that advanced the state of the art and on what is generally described as *high technology*. Therefore, to include more specifically the active instrumentation interface between physics and the more traditional manufacturing sectors of the economy--steel, drugs, chemicals and consumer goods, to name only a few, in which many old parameters are being measured and controlled in new and ingenious ways--a separate panel was established.

Panels were also appointed to centralize the statistical data-collection activities of the survey and to address the questions of physics in education and education in physics. In addition, an extended report on the dissemination and use of the information of physics was prepared by a member of the Committee. With the exception of the one on statistical data, all these reports are included in Part B of Volume II; the Statistical Data report constitutes Part C of Volume II. The Survey Committee is deeply grateful to Conyers Herring, Chairman of the Statistical Data Panel, who saw this effort through to completion and to others who assisted in the gathering and analysis of the statistical material that forms the basis for this report.

Support for the survey activity has been provided equally by the Atomic Energy Commission, the Department of Defense, the National Aeronautics and Space Administration, and the National Science Foundation. Additional assistance has been provided through grants from the American Physical Society and from the American Institute of Physics.

To these agencies and to other organizations and individuals who helped to make this survey possible through their contributions, I express both my personal thanks and that of the Committee and its panels.

D. ALLAN BROMLEY, *Chairman*
Physics Survey Committee

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I

INTRODUCTION

I.1 Nature of This Report

When the Physics Survey Committee was established by the National Academy of Sciences in 1969, it was decided that among its numerous panels there should be one charged with coordinating the collection and analysis of statistical data relating to the sociology and economics of the physics enterprise. The reasons for setting up such a panel were of two sorts, which may be categorized as "internal" and "external." To make the work of the Survey [illegible]mittee internally consistent, the various subfield panels obviously needed to adopt uniform definitions and, whenever possible, to obtain data from comparable sources. Moreover, the gathering of data from external organizations, such as government agencies, industries, and universities, obviously could be carried out more efficiently and with less inconvenience to these organizations by a single Data Panel than by many independent subfield panels. Therefore, as much of the gathering of socioeconomic data as possible was to be channeled through the Data Panel.

In addition to its primary function of serving the Survey Committee and the subfield panels in the manner just described, it was also thought that, after the data needed by these groups had been collected and turned over to them, the Data Panel might prepare an exhaustive and systematic compendium of data relevant to the functioning of the physics community. If such a compendium could be prepared, and periodically updated, it would be tremendously useful to physicists, research and educational organizations, government agencies, and the like. Unfortunately, this report is not the compendium that was envisaged. The demands on the time of the Data Panel and its staff proved of longer duration than had been anticipated, and almost no time was left for a leisurely assembling of data on a large scale. Moreover, funds available to the Survey were limited, and it seemed wasteful to republish data already presented elsewhere, especially in the earlier volumes of *Physics in Perspective*, merely to have all the data presented together.

The philosophy adopted for this report is, therefore, not encyclopedic but rather a philosophy of making publicly available, in as orderly a manner as possible, those items of data in our possession that may be of interest to the physics community and others and that have not been presented elsewhere. Because of the latter condition, the resulting collection is something of a hodgepodge. We have tried to ameliorate this situation to some extent, however, by occasional cross-references to data presented in other volumes of *Physics in Perspective*, and by including, in Chapter V, a condensed but we hope usable index to data presented in the figures and tables of this and the other volumes.

I.2 Sources of Data

I.2.1 TYPES OF DATA AND SOURCES

Most, though not quite all, of the data of interest to us are represented by numerical values of some dependent variable y, shown in their dependence on one or several independent variables x, which may or may not be identified by numbers. One encounters the following types of dependent variables y:

1. People: i.e., numbers of persons or fractions of some population. Thus, the entry in a table or the ordinate of a figure may be "number of physicists," "number of students," "fraction of respondents," etc.
2. Money: Typical quantities tabulated or graphed are dollar amounts of support, salaries, costs, etc.
3. Publications: i.e., such things as number of papers, fraction of papers, number of books or reports, etc.
4. Miscellaneous: The number of quantities other than the three types mentioned above, for which numerical data can be given, is of course large. They can be as diverse as "average age," "maximum voltage of accelerators," "time lag between submission and publication," etc. However, it is not unreasonable to group all these together in a miscellaneous category, as all such items together seem to constitute a rather less bulky fraction of the material of interest to a study such as ours than do the three preceding categories.

We shall use these four categories as the basis for the organization of our index in Chapter V. Table I.1 gives some crude indicators of the relative bulk of material one is likely to encounter in each of these categories. The top row of figures refers to an extensive bibliography of sources of data about physics and physicists compiled a few years ago for the American Institute of Physics (AIP) by Professor A. L. Harvey.* Here, the numbers represent the number of documents the principal emphasis of which is on data of each of the four types. In the other rows of Table I.1 the entries represent numbers of figures and tables, the ordinates or entries of which represent data of each of these types. In sheer bulk, it appears that in all cases data on people are the most voluminous.

TABLE I.1 Distribution of Data in Various Collections over Four Major Categories

Number of Items Presenting (or Emphasizing) Data of Each Category	Category			
	People	Money	Publications	Misc.
Documents referred to in the Harvey Report[a]	334	73	≈5	174
Figures and tables in *Physics in Perspective* Vols. I, IIA, IIB	184	184	40	122
This volume, excluding Appendix	168	21	29	18

[a] From its "Index by Data Category." The numbers add to considerably more than the 220 documents indexed, because many documents contain important data of more than one type. The entry 5 in the publications column is a guess based on scanning titles of documents.

Usually the interest of data of any of these types lies in its dependence on various auxiliary variables. The important categories of such variables are the following:

1. Time. It is nearly always of interest to know how any given quantity has been changing over the years.
2. Discipline or type of activity. One may compare physics with other sciences and subdisciplines of physics with one another or contrast basic research with applied research, with teaching, etc.

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*Harvey, A. L. *Statistical Data Resources of Physics and Physicists: An Index*. New York, N. Y. : Education and Manpower Division, American Institute of Physics (Pub. R-228), 1970.

3. Geographical or institutional entities. For example, one may compare different countries with each other, universities with industrial or government laboratories, research funded by different agencies, etc.

4. Characteristics of persons. When the dependent variable y is a number of people or a fraction of a population, it can be presented as a function of various other characteristics or quantities besides the ones just named. Examples are age, sex, possession of certain degrees, academic rank, etc. Table I.2 shows the extent to which each of these various types of independent variable has been used in the figures and tables of this report and in those of the earlier parts of *Physics in Perspective.*

TABLE I.2 Frequency of the most Important Types of Independent Variables in the Figures and Tables of this Report and of the Earlier Volumes of *Physics in Perspective*[a]

Type of Independent Variable	*Physics in Perspective* Vols. I, IIA, IIB	This Volume (Excluding Appendix)
Time	515	235
Discipline or activity:		
Field of science	449	232
Type of activity	24	23
Geographic or organizational:		
Geographic region	462	228
Working institution	107	111
Source of support	64	50
Personal characteristics:		
Age	14	23
Degree or rank	112	148

[a] Number of figures or tables in which entries for two or more values of the independent variable are compared.

Data of any of these types can be obtained from a variety of sources. Many of the data of interest for a study such as ours can be acquired by consulting tabulations that have been prepared by various other organizations, especially those of government agencies. We shall discuss some of these sources briefly in Section I.2.2. Here, we wish only to classify the means by which the original gathering of a mass of data can be performed. Among the many possible sources of data, three are of particular importance for the type of material of interest to us:

1. Individuals. Questionnaires filled out by individuals constitute an especially important source; we shall discuss their utility and limitations presently. Alternatively, one can gather information from individuals by interviewing them in person or by impersonal observation.

2. Organizations. Organizations, private or governmental, have statistics and records that can be used as data sources either by examining them directly or by asking officials of the organizations to fill out questionnaires.

3. The scientific literature. Unlike many other objects of socioeconomic study, a scientific discipline like physics leaves a record of much of its most important activity in the form of journal articles and other publications. These are, in turn, collected and indexed in the secondary literature. Thus research journals, abstract journals, and the like provide an extraordinarily rich mine from which to extract information on many subjects: for example, who is doing physics where; how different subfields and disciplines interrelate; or how much impact certain types of physics work have and where it is felt.

Questionnaires deserve a special comment. Those mailed to thousands of individuals can provide copious statistics in which random fluctuations are minimized. But, unless they are intelligently managed and carry high prestige, the percentage of nonrespondents is apt to be high, and one must then worry about whether the nonresponding population has the same statistical characteristics as the responding population. One should also think of the cost to the nation represented by the expenditure of time required from those who fill out the questionnaires. For example, it has been estimated that the time invested by respondents in filling out the forms for the 1970 National Register of Scientific and Technical Personnel could well have been of the order of $2 million.* Thus a sensible policy is to use large-scale questionnaires sparingly, restricting them to cases like the National Register (unfortunately now discontinued) in which comprehensive data are of vital importance and in which the prestige, regularity, and good management of the enterprise combine to ensure a high level of response. Similar considerations apply, though slightly less strongly, to comprehensive questionnaires circulated to all organizations of a given type, for example, to all university physics departments. Such questionnaires tend to be more complicated than those circulated to individuals, and although the number of recipients is smaller, they are apt to be very busy people.

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*Testimony of C. Herring before the Subcommittee on Science, Research, and Development, Committee on Science and Astronautics, U.S. House of Representatives, [illegible]ebruary 29, 1972.

The loss if they fill out the questionnaire sloppily can be great.

Many types of data can be collected more quickly and efficiently by sampling techniques. The success of public opinion polls in this country attests to the effectiveness of such methods for even quite large-scale surveys.

In our work we have made use of existing data sources whenever possible. The following section is devoted to a brief discussion of some of the more important of these. However, we found it necessary to collect a considerable amount of new data. Our philosophy in doing this, and a list of the major data-gathering projects we undertook, will be given in Section I.2.3.

I.2.2 PRINCIPAL OLDER SOURCES

We have mentioned briefly the Harvey Report,* a rather comprehensive and quite useful bibliography of sources of data about physics. This report, prepared at the AIP during 1969, with the support of the National Science Foundation (NSF), describes some 220 documents, issued by government agencies, learned societies, and other groups in the United States since 1960, plus a few foreign items or items of earlier date that are of particular value. The coverage is intended to be fairly exhaustive for manpower, educational, and funding data assembled in this country in the 1960's. As we have seen in Table I.1, however, coverage of data on publications was apparently not attempted. Practically all the documents referenced are available in the files of the AIP. The report also lists a number of earlier indexes and bibliographies.*

Having directed the reader to a fairly complete source of information about earlier collections of data, we may now limit our mention of particular collections of data to a few that have proven especially useful for the work of the Physics Survey Committee. We shall group these according to type of source organization.

Government Documents. Since the early 1950's, the NSF has issued annually *Federal Funds for Research, Development, and Other Scientific Activities.* Obligations incurred by the various federal agencies for the support of basic research, applied research, and development in the various fields of science and engineering are listed for each of three consecutive fiscal years, the latest of these being represented by the budget submitted to Congress but not yet passed. The degree of detail provided can be indicated by the following remarks: Some data are given only for "physical sciences," others for a finer subdivision, in which physics is broken down into four subfields; performers of the work are separated into intramural government organizations, industrial organizations, federally funded research and development centers, colleges and universities, nonprofit organizations, and foreign organizations; as for the funding entities, several subagencies are listed for the Departments of Defense and Health, Education, and Welfare and other large departments, although the Atomic Energy Commission (AEC), the NSF, and others are not subdivided. Although valuable as a general guide

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*Harvey, A. L., *op. cit.*

to the pattern of government support, this publication has a number of limitations that should be borne in mind. The separation into basic research, applied research, and development is based on the motivation for the work being pursued; the distinctions are necessarily somewhat ambiguous and may be interpreted differently by different agencies when they report their figures to the NSF. (In Section III.1.1 we shall present our philosophy on the separation of "research" from "nonresearch.") The subdivision of physics is not as detailed as was needed for the work of the Physics Survey Committee. Most serious of all is that there is no effective supervision of the judgments made by the different agencies in reporting their figures. We shall see in Section III.2.2 that a quite unreasonable picture can sometimes result from taking the figures at their face value.

Another important publication of the NSF, biennial until 1971, has been *American Science Manpower*. This was a tabulation of data collected by the National Register of Scientific and Technical Personnel. In its detailed tables, scientists are divided by discipline (physics, chemistry, etc.), and occasionally by subdiscipline (acoustics, nuclear physics, etc.). For each discipline, scientists are further subdivided according to the most important pairs of the variables age, highest degree, employment status, type of employer, primary work activity, years of professional experience, major subject of highest degree. Extensive data are also given on median salaries, geographical distribution, number receiving federal support, and a few other characteristics. The only shortcomings of this compilation for our purposes are that since it covers so many disciplines it cannot give as much information about physics as was needed for the work of the Physics Survey Committee. Moreover, the subfields used although comparable in size with those of the Physics Survey Panels are not identical with them.

A third publication of the NSF is the annual *National Science Foundation Grants and Awards*, which lists, by field of science, state, institution, and principal investigator, the titles, durations, and dollar amounts of all grants and awards for research and other science-related activities. Some totals appear in the NSF's internal *Databook*.

Similar to this publication is the quarterly one, *NASA's University Program*, issued by the Office of University Affairs of the National Aeronautics and Space Administration (NASA). Here again, titles, institutions, principal investigators, durations, and amounts are given for all grants or contracts supported by NASA in universities. The different disciplines are separated, as are the different NASA subagencies responsible for funding.

The AEC issues annually *A Statistical Summary of the Physical Research Program*, which gives data on manpower, publications, and funding for work in federally funded research and development centers, educational institutions, research institutes, and industrial laboratories. The data are subdivided according to eight AEC discipline categories, and various other statistics are given.

Although their data are rarely broken down to as fine a specialty as physics, the compilations of the Bureau of Labor Statistics are of especial interest in that they are obtained by intensive surveys of the civilian economy and are independent of such commonly used other sources as the National Register. Of particular interest in connection with demand extrapolations is their bulletin 1648, *PhD Scientists and Engineers in Private Industry 1968-80.*

Publications of the American Institute of Physics. The *Physics Manpower* series, published every few years by the AIP, provides a convenient assemblage of statistics from the National Register, U.S. Office of Education, National Education Association, and other sources, most notably the data collected by AIP from physics departments throughout the country. Over half is devoted to physics education. Data on employment of physicists are broken down by salary, work activity, type of employer, highest degree, age, and subfields, much as in *American Science Manpower.* However, the data on physics are much more accessible and are often presented in graphical form.

The annual *Directory of Physics and Astronomy Faculties* lists all North American colleges and universities, with the names and ranks of all faculty members in physics, applied physics, and astronomy departments. This information is obtained by direct contact with the departments involved.

The AIP has also issued some useful studies of the literature of physics, most of which are not indexed in the Harvey Report. Two studies of particular value are *Journal Literature Covered by Physics Abstracts in 1965,* by S. Keenan and F. G. Brickwedde (Report ID 68-1, 1968) and *Institutional Producers of Physics Research,* by M. Cooper and H. M. Watterson (Report ID 69-3, 1969).

Publications of the National Academy of Sciences-National Research Council. The Office of Scientific Personnel of the National Research Council maintains a Doctorate Records File containing detailed information gathered, with the cooperation of graduate schools throughout the country, from essentially all recipients of doctorates in the United States. Extensive data from this file have been presented in *Doctorate Recipients from United States Universities 1958-1966* (NAS publication 1489, 1967) and in supplemental yearly summaries issued since. Geographic and institutional distributions are given in considerable detail. Although most of the data are broken down only into major disciplines (i.e., physics, chemistry, earth sciences), some 14 subfields of physics, unfortunately not identical with those of the panels of the Physics Survey Committee, are separated in the totals. Of particular interest is the inclusion of information on initial postdoctoral employment. A study directed especially to this subject is *Employment of New PhD's and Post-Doctorals in 1971* (Report OSP-MS-5, 1971). This study was based on rather detailed special questionnaires sent to academic departments.

A number of extensive studies have been made by the Office of Scientific Personnel based on questionnaires to samples drawn from known doctorate recipients of past years and designed to explore the subsequent development of their careers. These studies report extensive data on geographical migration, salaries, types of employment, and the like. However, discipline specialization of the data is usually not on a fine scale, and many figures are reported only for "physical sciences."

Two studies, similar in nature to that of the Physics Survey Committee and in closely related fields, have been in progress almost simultaneously with ours, and each has also made use of a data panel. One is that of the Astronomy Survey Committee, whose data gathering is described in *Astronomy and Astrophysics for the 1970's:* Volume 2, *Reports of the Panels,* Chapter 9 (NAS, 1973). The other is that of the Committee on the Survey of Materials Science and Engineering, whose Summary Report is to be published shortly by NAS, and whose subsequent detailed report is expected to contain an extensive section on manpower, funding, and literature data for the materials field.

Miscellaneous Sources. The Organization for Economic Cooperation and Development (OECD), whose membership consists of most of the nations of Western Europe plus Japan, Canada, and the United States, has prepared a series of *Reviews of National Science Policy,* which surveys science and technology in various leading member and nonmember countries. Although the data are nearly all from official or other public sources, and are rarely specialized to as fine a scale as physics, they are sometimes discussed with useful critical insight. The studies are also of value simply because they try to discuss many countries from a unified point of view. The OECD has also issued a series of *Statistical Tables and Notes* on research and development in member countries that contains much information on manpower, funding, and organizations in the governmental, industrial, educational, and nonprofit sectors of the various countries. Further valuable studies on international migration of scientists and engineers have been conducted.

In the discussion of material from the AIP we mentioned that statistics on publications in physics provide valuable indicators of the scale and distribution of research and the interrelationship of different geographic and intellectual areas. Without naming further data sources specifically, we would like to stress here the utility of many data that can be found in the documentation literature. Among the organizations that have sponsored useful collections of such data special mention should be made of the Abstracting Board of the International Council of Scientific Unions.

I.2.3 NEW DATA GATHERING PROJECTS

The sources of data discussed in the preceding section, though extensive and useful, failed to answer many questions that were of interest to the Physics Survey Committee. Manpower and funding data, even when broken down according to subfields of physics, have not been available for subfields as finely subdivided and as clearly defined as was needed. As we noted in Section I.2.2, funding data from government agencies have been particularly ambiguous; this ambiguity is clearly apparent, for example, in the Pake Report.* There have been almost no quantitative data on the support

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***Physics: Survey and Outlook* (NAS-NRC, 1966).

of physics research in industrial laboratories or on the output of these laboratories to the physics literature. The resources invested by universities from their own funds in the physics research enterprise have also been inadequately investigated. And one can think of a host of small but intriguing questions on the sociology of physics to which none of the previously available sources supplies answers. Although the resources and abilities of the Data Panel were far too limited for it to attempt to fill all these gaps, there obviously were many useful things that it could do.

In Section I.2.1 we mentioned some of the disadvantages of large-scale questionnaires. We decided not to attempt to gather information from the physics community in this way. It was clear, however, that a rich mine of potential data existed in the tapes on which the complete store of replies to the National Register questionnaires were recorded. In addition to the obvious possibility of obtaining more detailed tabulations and cross-correlations of data pertaining to physicists than had previously been published, the tapes offered possibilities for obtaining entirely new types of information. As described in more detail in Section II.1.1, the replies on specialty of present employment and on additional specialties of competence afford a wealth of information on the closeness of different specialties to one another, or their remoteness, and provide a tool for fairly objective separation of physicists and their specialties into groupings corresponding to major subfields of physics, for example, the subfields to which the various panels of the Physics Survey Committee were assigned. In addition, the tapes for different years have been used to generate longitudinal files in which data from the same respondent, if he has answered questionnaires in a succession of years, are collected, and changes in employment, specialty, salary, and the like can be studied statistically. (Respondents, of course, remain individually anonymous.) It was decided, therefore, to examine the Register tapes in considerable detail and to make a small-scale study of the available longitudinal files.

Only one other data-gathering project of a comprehensive nature was undertaken. This was a survey of the records of the principal agencies of the federal government responsible for the support of physics research, to isolate the amounts of such support and allocate it to the various subfields of physics, as defined by the domains of the various panels of the Physics Survey. This study was done through the courtesy of officials in the agencies involved, who worked in close collaboration with the Staff Scientist of the Data Panel, to ensure uniformity of definitions from one agency to another. However, not all agencies could be studied adequately, and, as we shall see in Section III.2, a great deal of intelligent guesswork fortified by a variety of auxiliary studies was required to round out the funding picture.

The most important of the remaining projects undertaken by the Data Panel were sampling studies of one kind or another. Most of the questions encountered were of such nature that an approximate answer would be enormously better than no answer at all and that a highly exact answer was almost impossible to define. The speed and convenience of sampling studies therefore make them especially attractive, the more so since with this approach it is often possible to reformulate a question after the study has begun.

The most extensive sampling study undertaken was an article-by-article survey of about 4500 articles randomly selected from entries in *Physics Abstracts*. This survey was designed to reveal the distribution of physics research activity, as it is manifested in publication, among different countries, different types of institutions, and the different subfields of physics. As the Survey progressed, we became increasingly convinced that the literature of a science like physics is the best possible indicator of what can be called research activity. The British physicist, J. M. Ziman, has pointed out in a perspicacious little book* that what gives science its power and distinguishes it from many other worthwhile human activities is the wide dissemination of new results throughout the scientific community, followed by extensive criticism, leading to ultimate consensus. Thus, as we describe at greater length in Section III.1.1, we believe that it is possible to make a fairly clear distinction between "research" and "nonresearch" but that the distinction between basic and applied research is necessarily exceedingly fuzzy. In the studies of federal funding mentioned previously, and the studies of other types of funding to be discussed in subsequent sections, we therefore endeavored to isolate the funding of activities leading to publishable results. As we shall see in Chapter III it is useful to have the opportunity to check the general consistency of the findings of investigations of funding with those of studies of the literature.

Studies of industrial and university funding of research and other characteristics of physics research in these two environments necessitated obtaining data from some of the organizations involved. The data needed were not always easy for these organizations to supply, and we were conscious of how painful would be the demands on the time of anyone to whom we addressed inquiries. Fortunately, we were able to select small samples of institutions of both types, which at the same time were adequately representative of the diversity of the national populations, yet were represented by persons to whom we could appeal for help by use of close personal contacts. This procedure ensured a high percentage of conscientious responses. We wish to express our profound gratitude to the representatives of these organizations who were willing to devote so much time to make our projects successful.

A number of smaller studies of samples of people, documents, or merely data from government publications were made. These, some of which will be discussed at appropriate places throughout the report, often proved helpful in filling in our picture of the functioning of some part of the physics community.

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*Ziman, J. M. *Public Knowledge: The Social Dimension of Science.* Cambridge University Press, 1968.

II
MANPOWER DATA

II.1 Studies Based on the National Register and Other Nationwide Sources

II.1.1 INTRODUCTION TO THE NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

Much of the information on manpower in *Physics in Perspective*, and particularly in Parts II.1.2 and II.1.3 below, was based on data from the NSF National Register of Scientific and Technical Personnel. Therefore, a detailed discussion and evaluation of this major data source seems in order.

From the mid-1950's until 1970, the NSF conducted a series of biennial questionnaire surveys called the National Register of Scientific and Technical Personnel. The various scientific societies—in physics, the AIP—were responsible for identifying the specialties that comprised their fields, setting criteria for inclusion, and collecting the data. Statistical tables of data from these surveys, for a wide variety of sciences, were then regularly published in the NSF's *American Science Manpower* series.

The Register was in two respects unique. First, it was designed to be a complete survey of manpower in various sciences rather than a sampling operation. Second, unlike the surveys of the Bureau of Labor Statistics and other NSF surveys, it was directed to the individual scientist rather than to his employing institution. The uniqueness of this data source increases the difficulty of measuring its reliability.

The Physics Survey depended heavily on National Register data for several reasons. Most sources presented data on physical sciences, sometimes with a further breakdown for physics as a whole; the National Register was one of the few sources in which physics was subdivided into specialties. Since the Physics Survey was as concerned with the subfields of physics as with the overall field, this feature was most useful. Second, because the Register had been a continuous operation throughout the 1960's, comparative data over time could be derived. Finally, both current (1970) and past comparative data from the Register were available on computer tape. This availability on tape was particularly valuable, because, as a result, data analysis was not limited to published definitions, categories, and table layouts. Register subfields could be redefined to fit more closely the scope of the subfield panels of the Physics Survey. Categories such as employer type could be revised to show separately the federally funded research and development centers, major employers of physicists. Work activity groupings could be redefined so that categories of no relevance to physics were eliminated. Data could also be made more nearly comparable over time. Working directly with the Register computer tapes permitted a flexibility seldom possible with other data sources.

Although Register data have many advantages, problems occur in their interpretation. To deal with the numbers presented, the user needs to know how representative they are and the nature of any biases. In the following subsections we shall consider several points relating to the opportunities and limitations presented by the Register and our use of it.

II.1.1.1 *Adequacy of Coverage*

A basic question one should ask about the Register data is: How completely do they cover physicists? Professional societies identify the groups of scientists who are to receive their questionnaires. Thus scientists who are not known to a society are not included. In the case of physics, this source of error is probably relatively small, for the AIP attempts to identify and include in the survey physicists who are known from a variety of sources even though they are not members of one of the AIP societies. Coverage also is incomplete to the extent that persons receiving the questionnaire fail to fill it out and return it.

Completeness of coverage is probably most useful in the case of doctoral scientists. They are almost automatically included in any count of scientific personnel. At lower educational levels the definition of a scientist is less clearcut and varies widely among societies and sources. The AIP's criterion for inclusion as a physicist was anyone with an advanced degree in physics or a baccalaureate in physics plus two years of professional experience in physics or an equivalent background. It is difficult to estimate the size of such a population.

Perhaps the most exhaustive attempt to assess Register coverage of doctorates was that of the Commission on Human Resources and Higher Education.* The Commission based its study on a comparison of the Doctorate Records File (maintained by the National Academy

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*Folger, J.K., H.S. Astin, and A.E. Beyer. *Human Resources and Higher Education*. New York, N.Y.: Russell Sage Foundation, 1970.

of Sciences Office of Scientific Personnel) and the National Register. Information for the Doctorate Records File is obtained directly from universities and supplemented by a questionnaire to be filled out by the graduate. The File is believed to include 99 percent of all the doctorates awarded in the United States. The Commission attempted to identify by name in the 1964 National Register all persons who received a science doctorate in the United States between 1957 and 1962. A number of auxiliary studies were conducted to correct for deaths and immigration and emigration. The basic datum sought was the number recorded in the Doctorate Records File as having a U.S. baccalaureate and doctoral degree who appeared also in the National Register. Possession of a U.S. baccalaureate degree was interpreted as evidence that the individual was a permanent resident of the United States and would seek employment in this country. The Commission found that 78 percent of the physics doctorate recipients appeared in the 1964 National Register; therefore, this number could be used as an estimate of coverage of the Register in physics. A lower coverage was estimated for most other scientific disciplines.

How important is completeness of coverage? If no bias in coverage exists, that is to say, if nonrespondents are similar to respondents, figures can be inflated to the proper expected total by using the inverse of the rate of no response. In the mid-1960's the NSF conducted a special survey of nonrespondents and found few differences from respondents on major variables such as level of degree and type of employer.

The National Register, therefore, appears to have been, for physics, a relatively complete and unbiased source of information on manpower. However, in attempting to compare data in a particular Register with another source or with Registers of earlier years, problems still exist. Such problems result principally from variation in basic definitions. One cannot use Register or other data without clearly understanding what they relate to. A few examples illustrate problems related to coverage and definitions and show the need for caution in the interpretation of data.

As a first example, we compare physics and astronomy faculty members included in the National Register and in the AIP's annual *Directory of Physics and Astronomy Faculties*. The Register reports numbers of faculty members by self-reported faculty rank. The AIP independently obtains actual name listings from the heads of college and university physics departments for inclusion in the *Directory of Physics and Astronomy Faculties*, which is probably a more nearly complete and valid source, at least for regular faculty. Table II.1 presents the results of this comparison.

The second row in Table II.1 shows the number of faculty in each academic rank reported by the AIP for the 1966-1967 academic year. The first row shows the numbers reported in *American Science Manpower 1966*. Since most physics departments were growing at this time and AIP figures for 1966-1967 represent data for a later date than those of *American Science Manpower*, data for 1968 from this source are shown in the third row. In the three professorial ranks the mean of the numbers reported in *American Science Manpower* for the two years is between 78 percent and 83 percent of the number

TABLE II.1 Number of Faculty Members by Rank

Source	Prof.	Assoc. Prof.	Asst. Prof.	Instructor	Other
ASM[a] 1966	1691	1322	1832	793	1056
AIP[b] 1966-1967	2449	1830	2686	1389	641
ASM[a] 1968	2128	1713	2345	757	1057

[a] *American Science Manpower.*
[b] *Physics Manpower 1969* (American Institute of Physics, New York, 1969).

reported by AIP, or slightly higher than the 78 percent Register coverage reported for physics PhD's by the Commission on Human Resources and Higher Education.

In the two lower ranks, however, discrepancies appear. If the Instructor and Other categories are added, the National Register coverage for them appears to be 90 percent of that of AIP. If the figures are inflated by the factor used previously, the result suggests that the Register is including approximately 260 more faculty members in the lower ranks than the AIP, a 13 percent overinclusion. The difference results primarily from a difference in definition between the individual and department head. Apparently some individuals in lower ranks considered themselves (or were considered by the Register) faculty members, although department heads did not define them as such. The breakdown at lower faculty ranks varies even more. Individuals are more restrictive in defining themselves as instructors than are department heads. For the user of Register data, these findings suggest that lower faculty ranks are probably overrepresented and that any breakdown of lower faculty ranks should be treated with extreme caution as academic rank at these levels has not been standardized.

The attempt to examine the growth of a borderline subfield of physics that includes many nonphysicists, such as acoustics, provides another example of the effect of varying definitions, as Table II.2 shows.

According to the Register data, the population of acoustics, with some peculiar fluctuations, has been virtually stable. However, membership directories of the Acoustical Society of America and publications in its journal show growth. Membership increased by more than 50 percent in the nine-year period, and publications by almost 90 percent.

Has the Register missed physicists in acoustics? To answer this question is difficult, because the Acoustical Society has not collected data on the educational and employment background of their members. A general feeling, substantiated by a more recent survey, is that the Society's membership is exceedingly diverse, consisting of physicists, engineers, psychologists, and a variety of other scientists. Although complete figures on these groups are not known for the years indicated in Table II.2, probably more than half of those who are identified with acoustics are from disciplines other than physics.

TABLE II.2 Growth of Acoustics

Year	ASM[a]	ASA[b] Membership	Pages Published in *JASA*[c]
1960	1260	2782	1781
1962	1454	3301	2079
1964	1381	3735	2525
1966	1261	4007	2979
1968	1296	4403	3369

[a] In *American Science Manpower* series, scientists indicating first competence (1960-1966) or present work experience (1968) in acoustics.
[b] Acoustical Society of America.
[c] *Journal of the Acoustical Society of America.*

Clearly, as Table II.2 shows, acoustics has been growing; however, growth rates by discipline may differ. The physics component of acoustics has apparently remained approximately stable, whereas the other components—engineering, psychology, and the like—have increased.

As a third example, physicists employed in industry are shown in Table II.3, which is based in part on figures collected by the NSF and the Bureau of Labor Statistics.*

TABLE II.3 Numbers of Physicists (Thousands) Employed in U.S. Industrial Organizations

Year	*American Science Manpower*	NSF-BLS Survey
1960	8.6	12.5
1962	9.8	14.0
1964	9.0	15.6
1966	8.3	16.2

According to the National Register, the number of physicists in industry remained stable during the years indicated. However, the figures in the third column of the table show fairly substantial growth. The problem again stems from definitions. The Register obtains information from individuals and sets clear criteria for who is and is not a physicist; the NSF-BLS survey obtains information from employers and leaves the categorization of individuals to them. Anyone to whom an employer gives the title of physicist is recorded as such, regardless of his background education

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***Employment of Scientists and Engineers in the United States.* Washington, D.C.: National Science Foundation and Bureau of Labor Statistics, 1968.

and training. With so loose a definition, inflated figures might be expected; but the problem is even greater, for there is no way of knowing how such loose definitions change with time. During a period of increasing demand, such as the early 1960's, there could well be an increasing number of employer-defined physicist positions but little change in the number of AIP-defined physicists so employed. The additional positions could have been filled by engineers and technicians. It must be remembered that while industrial demand was growing in the early 1960's so, too, was academic demand, and academia usually has been the preferred home of physicists.

These examples and comparisons indicate not that one source is good, another bad, but rather that each is measuring somewhat different phenomena. If, for example, one wanted to examine the number of physics faculty members by the strict standard of the department chairman, one would use the faculty directory; if one was studying the number of physicists employed by universities, the National Register could be used, with the necessary inflation factor. If one was interested in the growth of acoustics, broadly defined, one would use the Acoustical Society membership or publication figures. If one needed information on the change in the physics component of acoustics, the National Register would be the appropriate source. And if one was concerned with the change in physics positions in industry, as defined by employers, the NSF-BLS statistics would suffice. Changing participation of physicists in industry would be shown by Register data. Comparisons of data sources can lead to useful hypotheses, for example, about the components of growth in acoustics, but cannot be taken at face value as indications of data source deficiencies, for the sources often cannot be equated.

With this background on advantages and problems in the use of Register data, we will look next at the way in which the Data Panel used these data and at some additional problems related to their interpretation.

II.1.1.2 *Cross-Sectional Studies*

Most of the manpower data used in the Physics Survey came from the 1964, 1968, and 1970 Register computer tapes. The *American Science Manpower* series provided data for other years, and AIP student surveys were useful for obtaining data on physics baccalaureates, graduate students, and new PhD's. The 1970 Register data were the most current available at the time of the Physics Survey. Data from 1964 and 1968 were used for comparative purposes to examine changes during the late 1960's.

A layout of the major analyses needed for these years was developed. The tabulations decided on will be described in Section II.1.2; they are summarized there in Table II.4. The totality of tabulations for the three years runs into the thousands. Many of these tabulations were used by the Data Panel in developing specific analyses. A selection of tables considered of greatest interest were reproduced from computer printouts and appear in Appendix A.

Additional tables are available at the NAS or the AIP to qualified persons for research purposes.

II.1.1.3 *Mapping the Subfields of Physics*

The collection of data on the physics population was the central task of the Data Panel; however, the Panel recognized that data on the various subfields would also be most useful. Such data could provide information not previously available on the unity and diversity of physics.

A major problem of the Data Panel was the allocation of the many categories and specialties of the National Register among the 11 subfields established for the Physics Survey. The Register data contained 19 major physics categories and 236 detailed physics specialties in addition to several specialties in other sciences that could be defined as interdisciplinary areas or interfaces with physics.

Using the 1968 Register data (available at the start of the Survey), two panelists assigned Register categories and specialties to the various subfield panels. Many of the specialties were clearly appropriate to particular panels. Others were less easily assigned. For example, where did electronics or health physics belong? A number of Register specialty groups appeared to be directly related to several subfields. How to allocate these in the most meaningful way was a major question.

The initial step in the procedure finally adopted was to identify the specialties that were clearly related to each of the Physics Survey panels. These groups were later termed Panels Proper. The next step was to identify single or groups of specialties that could be considered borderline cases. These specialties might be related to several panels. Thirty-six of these borderline groups were developed. Initially Herring and Keyes examined each of these and made an educated guess as to what their allocation should be—what proportion of the practitioners of a particular borderline group, for example, should be assigned to condensed matter, optics, and so on. However, when this task was completed there was a certain degree of dissatisfaction with this subjective allocation of relatively unknown groups. At this point it was decided that elements in the Register questionnaire might be used to develop a more objective and consistent method of allocation for these 36 borderline cases.

The Register questionnaire included both a question on specialty of present work activity and one on specialties of additional competence. It was thought that individuals whose specialties of present work activity were among the borderline groups would have a majority of their specialties of competence either in the borderline group or in the appropriate Panels Proper.

On the basis of this assumption all borderline groups (that is, individuals indicating one of the borderline groups as specialty of present work activity) were sorted in terms of specialties of additional competence, including both Panels Proper and borderline groups. For example, individuals currently working in electronics were examined to determine the specialties of additional competence; some indicated other electronics specialties, and others one of the Panels Proper, such as condensed matter. (Initially distributions on first and additional specialties of competence were examined separately; however, comparisons showed that second, third, and fourth competences were merely reflections of the first. Determinations were then made on the basis of specialties of first competence.)

Allocations were based on the percentage distributions of competence responses. If examination showed that an overwhelming proportion of competence responses were to a single Panel Proper, then this specialty or group of specialties was assigned to that Panel Proper. In most instances, a split allocation was indicated —50 percent condensed matter, 50 percent nuclear physics, or 25 percent optics and 75 percent atomic, molecular, and electron physics.

Whether this was the best way to deal with borderline cases is open to question. Many of the borderline groups were eventually assigned to the same panels as they had been with the earlier subjective judgment procedure. Subjective re-examination showed differences when they occurred to be consistent, if not expected.

Appendix B shows the allocation of 1968 Register specialties among subfield panels. Those that were allocated by means of the analysis of borderline groups are listed at the end of each subfield section. The remaining specialties that did not clearly fit into Survey Panels were combined into a miscellaneous category. This category included a large number of people whose specialty was physics teaching, others with specialties outside physics in chemistry, engineering, or computer science, and a few that could not be classified. The fractions following each overlap group indicate the proportion allocated to a particular subfield.

The Data Panel believed that this method of specialty allocation, although not perfect, was the most objective and consistent response then available to the problem of defining physicists and their subfields, which has always presented difficulties. We shall discuss the analogous problem of classifying the literature of physics in Section IV.1.1.

II.1.1.4 *Other Problems of Definition*

A few additional problems among the data for the 1964, 1968, and 1970 Registers can be briefly summarized.

1. Increased coverage between 1964 and 1970 could be expected, although for physics this factor should have little effect as procedures did not undergo major change. In making comparisons, the increased coverage would imply a slight exaggeration in figures on growth.

2. Questions dealing with competence varied slightly between 1964 and 1970; further, in data collected from the Register tapes the Data Panel used specialty of present work activity, whereas tables from *American Science Manpower* used data on specialty of first competence.

3. In the three years examined, the Data Panel treated federally funded research and development centers as a special category; published material from *American Science Manpower* distributed these institutions according to administrative groups, such as university or industry, rather than presenting a separate tabulation.

In comparing Register data with other sources it is often necessary to examine the exact phrasing of the questions; therefore, to aid in such comparisons Appendix A includes copies of the 1964, 1968, and 1970 Register questionnaires.

II.1.1.5 *Longitudinal Studies*

In addition to cross-sectional studies, several longitudinal studies based on two longitudinal files were conducted. The first of these files, referred to as the 1960-1966 Longitudinal File, was developed from Register tapes by Robert McGinnis of the Department of Sociology, Cornell University, with the cooperation of the NAS. The Data Panel used information from this file on all PhD's who responded to all three Register surveys in this interval and who were defined by AIP as physicists in 1964. The data obtained showed mobility among subfields of physics, between physics and other sciences, among types of employers, among work activities, and among regions of the United States and other countries. (These relatively complex tables are available at the AIP to qualified researchers.)

In addition, the Data Panel worked with data on AIP-defined physicists, both PhD and non-PhD, from a 1968-1970 longitudinal file developed from Register surveys for these two years. The groups considered were

1. Physicists responding to both surveys who were PhD's (or non-PhD's) in both years
2. Physicists responding to both surveys who were non-PhD's in 1968 but PhD's in 1970
3. Physicists responding only to the 1968 survey
4. Physicists responding only to the 1970 survey

Analyses of data on the first two groups showed patterns of mobility among subfields, types of employers, work activities, and geographic areas. Further analyses of the second group also showed how new PhD's differed from other PhD respondents. The third group was studied to determine the characteristics of individuals who responded in 1968 but not in 1970. This type of analysis gives insight into the nature of the nonrespondent group. Analyses of the fourth group yielded information on characteristics of new respondents—whether they were older physicists who had failed to respond in 1968 or new entrants to the field.

A few definitional problems occur when comparing longitudinal with cross-sectional data. First, correlating 1964 specialties with those of 1968 and 1970 had presented some difficulties, which were greatly increased by additionally correlating those of 1960, 1962, and 1966. Neither specialty categories nor physics remained the same during this interval. Further, between 1960 and 1970 the point of reference of specialties changed. From 1964 on, specialties of present work experience were included on the questionnaire in addition to specialties of competence. As a result of these variations, subfield mobility based on current work specialization can be discussed only for the 1964-1966 and 1968-1970 intervals. Care must be exercised in the interpretation of data on mobility for the other years, for change in specialty of competence is different from change in specialty of employment. Changes in definitions of types of employers also occurred over the years, especially in regard to federally funded research and development centers. The data for 1964-1966 and 1968-1970 again appear to be the most consistent. Finally, none of the Register surveys made provision for the heavily university-based postdoctoral group. Consequently, when examining mobility from the university to other work environments, it is difficult to determine the number who are departing postdoctorates and those who are leaving regular positions. The postdoctoral group greatly proliferated in the late 1960's, which increases the difficulty of interpreting and fully evaluating the movement from the universities in the two time intervals.

Some of these problems were handled through age subclassification. This technique does not completely solve the problem of discrepancies but does throw light on major patterns.

As this and other portions of *Physics In Perspective* show, careful understanding and manipulation of a data source can produce useful analyses many steps beyond a simple tabular layout of raw figures. It is hoped that this effort will stimulate and guide further analyses of Register and other data.

II.1.2 TABULATIONS FROM THE PHYSICS PORTION OF THE NATIONAL REGISTER

Through the courtesy of the NSF, extensive analyses were made, first, of the 1968 National Register computer tapes, then extended to 1964, and, when the returns from the 1970 questionnaires became available, to that year also. Studying but one field—physics—we were able to make much more detailed tabulations and cross-correlations than those published biennially for the totality of science in *American Science Manpower*. Moreover, having grouped the specialties into the various subfields corresponding to panels of the Physics Survey Committee and the Astronomy Survey Committee, we were able to break the tabulations down by subfield whenever this seemed desirable. Such a breakdown is, of course, not available in *American Science Manpower*.

The wealth of possible subdivisions and correlations in the data can be appreciated from an examination of the National Register questionnaire, which is reproduced, in its 1964, 1968, and 1970 versions, in Appendix A. The 1964 and 1968 questionnaires were almost identical in regard to all the entries used for our tabulations, but there were some minor differences :

1. The wording of the question on professional identification (8 on the 1970 form) has varied slightly.
2. The questions on student and employment status (7 and 9 on the 1970 form) were a single question on the 1964 form.
3. Although all three questionnaires had a question on the specialty closest to present employment (13 on the 1970 form), the wording of the question on additional competence (18 on the 1970 form) has varied. In 1964 and 1970, the four specialties of greatest competence were requested; in 1968, four specialties other than the one closest to present employment were requested.
4. The alternatives offered for present principal employer (11 on the 1970 form) have varied slightly, as have the alternatives for first and second most important activity (12 on the 1970 form).
5. Academic rank (10 on the 1970 form) was not included on the 1964 form.
6. The 1970 questionnaire allowed responding physicists to identify themselves as theorists, experimentalists, or both.

With the possible exception of the slight difference in the identification of areas of additional competence on the 1968 form, these variations in the questionnaire were all sufficiently minor that it was possible to prepare tabulations that would be comparable for different years. These were obtained in the form of tables, with rows corresponding to possible alternative answers to some one question, columns to alternative answers to some other question; a selection according to answers to a third question, a fourth, and so on could be made simply by preparing many tables, one for each combination of the latter answers. Except for some tables that were prepared only from the 1970 tapes, the totality of tables developed for the three years is described, in a condensed notatation, in Table II.4. Here the rows correspond to different categories of tables, in the order in which they appear in Appendix A. Each such type of table has its rows and columns corresponding to the items in the black-bordered boxes. The number of rows of columns is the number indicated in the black-bordered box, augmented where so indicated by a total (t) or a grouping into quartiles (Q's). There is one such table for every combination of the variables indicated without a black-bordered box. Thus, for example, there are 3 × 19 × 7 = 399 tables of type 1 for any given Register year, one for each combination of a degree status (PhD or non-PhD or total), an employment specialty (one of 18 physics and astronomy subfields or total), and an employer type (one of five categories, "no response," or total). Each such table has rows corresponding to the seven possible types of primary work activity, and "no response" and total, and columns corresponding to the same alternatives for secondary work activity. Where 12 subfields are listed instead of 18, all subfields of astronomy except the borderline field, astrophysics and relativity, have been grouped into one.

A few additional tabulations were made from the 1970 tape. These were (a) subfield of employment by subfield of first competence for theorists, experimentalists, those identifying themselves as both, and nonrespondents to this question (type 16); (b) employment specialty by age and degree status for these four groups (type 17); and (c) employment specialty by professional identification and degree status for the same groups (type 18).

Printouts of all these tables are available for study at the NAS. We have made a selection of some of the most interesting ones, which are reproduced in Appendix A. This selection consists of the following:

1. Fourteen tables of type 2 (PhD or non-PhD; only t for subfield specialty; and 6+t possible answers to the employer type questions)
2. Twenty-six tables of type 3 (PhD or non-PhD; five employer types with t for work activity; seven types of work activity with t for employer type; t for all types of work activity and employer)
3. Twelve tables of type 8 (PhD or non-PhD; 5+t employer types; only 5 for subfield of employment)
4. Fourteen tables of type 8 (PhD only; 14 subfields of employment; only t for employer type)
5. Ten tables of type 9 (PhD or non-PhD; four combinations of sex and student status plus t)
6. Fourteen tables of type 10(14+t subfields of employment; only t for employer type)
7. Two tables of type 11 (PhD or non-PhD; only t for subfield of employment)
8. Eighteen tables of type 12 (PhD or non-PhD; 8+t answers to question on employer type; only t for subfield of employment)
9. One table of type 13 (non-PhD only; only t for subfield of employment)
10. Fifteen tables of type 13 (PhD only; 14+t subfields of employment)
11. Two tables of type 15 (PhD or non-PhD; only t for subfield of employment)
12. Six tables of type 16 (PhD only; 5+t employer types)

TABLE II.4 Tabulations Available from the 1964, 1968, and 1970 National Register Tapes

[illegible]ble Number and Name	Question or Dimension														
		Subfield Specialty Group[a]			Work Activity[b]		Maturation by Year Groups								
	PhD/Non-PhD (6)	Of Employment (13)	Of Additional Competence (18)	Employer Type[b]	Primary	Secondary	Of Experience	Of Age	Academic Rank[c] (10)	Citizenship (U.S./Non-U.S.) or birth (2, 5)	Field of PhD (6)	Sex, Student/Non-student (4, 7)	Employment Status	Base Salary	Extra Income
1. Work activity	2+t	18+t		6+t	8+t	8+t									
2. Work activity	2+t		18+t	6+t	8+t	8+t									
Employment specialty vs															
3. 1st additional competence	2+t	12+5	12+t	5-t	7-t										
4. 2nd additional competence	2+t	12+t	12+t												
5. 3rd additional competence	2+t	12+t	12+t												
6. 4th additional competence	2+t	12+t	12+t												
Work activity															
7. By years experience	2+t	12+t		5+t	8+t		9+t								
8. By age	2+t	12+t		5+t	8+t			12+t +0's							
9. Employment status	2+t	12+t										4+t	5+t		
10. PhD field by activity	PhD	18+t		5+t	8+t						8+t				
11. Academic rank by age	2+t	18+t						12+t +0's	10+t						
12. Salary vs total income	2+t	12+t		7+t										8+t	8+t
13. Citizenship and birth by age	2+t	12+t						12+t		4+t					
14. Additional employment	2+t	18+t		6+t 6+t											

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[a] For the 1970 tabulations plasma physics and physics of fluids are shown separately as well as combined, so the numbers 12-t and 18-t in this column become 14-t and 20-t, respectively.

[b] Number of possibilities in these columns varies according to whether the "no response" category is included.

[c] Not available 1964

II.1.3 DATA ON CHARACTERISTICS AND MOBILITY OF PHYSICISTS

Chapters 9 and 12 of Volume 1 of *Physics in Perspective* describe the flow of physics manpower from initial training to employment and present data on the employing institutions and work activities of physicists in various subfields. The sections that follow supplement these data with material on such characteristics as sex, citizenship, employment status, income, and the like and examine in greater depth the way in which physics as a discipline and physicists as a community changed during the late 1960's.

II.1.3.1 *Demographic Characteristics*

II.1.3.1.1 *Sex* The population of physics is principally male. Females represented approximately 2 percent of the PhD's and slightly more than 5 percent of the non-PhD's in both 1968 and 1970. Table II.5 shows differences in employment status of male and female physicists in 1968. The main difference relates to part-time employment; 1 percent of the males and 12 percent of the females are employed part time.

TABLE II.5 Employment Status by Sex, 1968[a,b]

Employment Status	PhD				Non-PhD			
	Male		Female		Male		Female	
	Number	%	Number	%	Number	%	Number	%
Full time	13,389	97	219	78	10,713	97	428	68
Part time	129	1	34	12	136	1	67	11
Unemployed, seeking	42		6	2	75	1	22	3
Unemployed, not seeking	13		11	4	25		104	17
Other[c]	230	2	10	4	151	1	7	1
Total	13,803	100	280	100	11,100	100	628	100

[a] Data on nonstudents only.

[b] 1968 data presented because of minor problems in the interpretation of the 1970 data on non-PhD's.

[c] Includes retired and no response to question on employment status.

A second difference pertains only to non-PhD's. Those who are not employed and not seeking employment are regarded as outside the labor force, at least temporarily. As Table II.5 shows, 17 percent of the female, non-PhD physicists have dropped out of the labor force, compared with less than 1 percent of the males. This finding could result from a lower degree of commitment among non-PhD women physicists, temporary family responsibilities, or lesser job opportunities.

Register data on women physicists also show the following.

1. Women PhD's are more likely to be employed in universities and colleges and less likely to be employed in industry than are men.
2. Women non-PhD's are more likely than male PhD's to be employed in secondary schools and junior colleges.
3. Women physicists' salaries are lower than those of male physicists, regardless of type of employer.
4. Women physicists less frequently receive government support than do male physicists.

II.1.3.1.2 *Age* The median age of PhD physicists in 1970 was 37.4 and that of non-PhD's, 32.9. Table II.6 shows the age distribution of physicists. Approximately 50 percent of the PhD's are in the 30-39 age group, and about 50 percent of the non-PhD's are in the 25-34 age group.

TABLE II.6 Age Distribution of PhD's and Non-PhD's, 1970

	PhD's		Non-PhD's	
Age	Number	Percent	Number	Percent
24 and under	5	—	815	4.6
25-29	1808	11.1	5411	30.7
30-34	4467	27.5	3844	21.8
35-39	3188	19.6	2409	13.7
40-44	2494	15.4	1732	9.8
45-49	1953	12.0	1537	8.7
50-54	966	6.0	874	5.0
55-59	631	3.9	548	3.1
60-64	408	2.5	331	1.9
65-69	231	1.4	121	0.7
70 and over	78	0.5	21	0.1
TOTAL[a]	16,229		17,643	

[a] Total refers to those whose employment was known. There were 19 PhD's and 36 non-PhD's who did not provide data on age.

Because of the heavy influx of new PhD's during the 1960's, the median age of the PhD group dropped from 38.2 in 1964 to 37.4 in 1970. Table II.7 shows the change in median age by subfield and convergence toward the overall median age in 1970. Such clustering about the median suggests heightened competition within age groups.

TABLE II.7 Median Ages of PhD's by Subfield in 1964 and 1970

Subfield	1964	1970	Change
Astrophysics and relativity	34.7	34.7	—
Atomic, molecular, and electron	36.5	35.3	-1.2
Elementary particle	34.1	34.2	+0.1
Nuclear	37.3	37.8	+0.5
Plasma physics and physics of fluids	36.7	37.0	+0.3
Condensed matter	36.7	36.4	-0.3
Earth and planetary	38.1	37.4	-0.7
Physics in biology	40.6	37.2	-3.4
Optics	40.3	38.7	-1.6
Acoustics	42.2	40.1	-2.1
Astronomy	37.4	35.0	-2.4
Miscellaneous	42.8	41.4	-1.4
All subfields	38.2	37.4	-0.8

In the 1970's the expected decline in new PhD's should result in a slowly aging community. The now young, heavily academically based populations in some subfields will show an increase in average age as academic positions decrease; the currently somewhat older, nonacademically based populations might increase slightly in number and decrease in average age.

II.1.3.1.3 *Place of Birth and Citizenship* In 1970, 75 percent of the PhD physicists in the United States were U.S.-born citizens. Approximately half (1700) of those who were foreign born became U.S. citizens; 1900 retained their foreign citizenship. The number of PhD physicists who were U.S.-born citizens increased by 50 percent between 1964 and 1970; however, the foreign-born PhD physicist population in the United States nearly doubled. The noncitizen group could be somewhat larger than the figures reported in the National Register survey, for many who do not become citizens are a transient group, often returning to the country of origin, and such groups are unusually undercounted in surveys.

Characteristics of the U.S.-born citizen, foreign-born U.S. citizen, and noncitizen groups vary. Table II.8 shows the distribution of these groups by age in 1970. The foreign-born U.S. citizens have a median age of 43.7 and constitute a relatively high proportion of the older (>60) age cohorts. In sharp contrast, the non-U.S. citizen group has a median age of 35, with four fifths of them in the 25-39 age range. The decrease in the number of noncitizens in the older age cohorts could result from return migration or naturalization.

TABLE II.8 Birth and Citizenship Status of PhD's by Age in 1970

Age	Total		U.S. Born Citizen		Foreign Born U.S. Citizen		Noncitizen	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
20	0		0		0		0	
20–24	5	100	1	20.0	0		4	80.0
25–29	1,896	100	1,536	81.0	64	3.4	218	11.5
30–34	4,537	100	3,498	77.1	204	4.5	687	15.1
35–39	3,220	100	2,290	71.1	275	8.5	530	16.5
40–44	2,521	100	1,789	71.0	367	14.6	286	11.3
45–49	1,975	100	1,486	75.2	313	15.8	107	5.4
50–54	982	100	730	74.3	159	16.2	41	4.2
55–59	647	100	483	74.7	126	19.5	15	2.3
60–64	434	100	305	70.3	103	23.7	10	2.3
65–69	296	100	202	68.2	71	24.0	2	.7
70–	99	100	69	69.7	22	22.2	3	3.0
All ages	16,612	100	12,389	74.6	1,704	10.3	1,903	11.5
No response	19		12		3		1	
Median age	37.4		37.0		43.7		34.9	

TABLE II.9 Distribution by Subfield of Citizen and Noncitizen PhD's[a]

				Foreign-Born								
	U.S.-Born Citizens			Citizens			Noncitizens			Total[c]		
Subfield[b]	1964	1968	1970	1964	1968	1970	1964	1968	1970	1964	1968	1970
A&R	78.5%	68.8%	69.8%	10.8%	11.2%	8.6%	10.8%	15.2%	17.6%	65	125	255
AME	75.3	74.7	73.0	13.2	10.3	10.1	11.5	11.8	13.3	660	1004	1102
EP	71.9	67.9	68.3	11.5	9.9	9.9	16.4	18.5	18.4	898	1294	1440
NP	80.9	76.7	74.6	9.6	9.4	9.4	9.4	10.7	12.3	1287	1802	1824
P&F[d]	72.8	69.5	68.5	16.0	15.5	15.0	10.7	11.2	13.1	707	931	1118
CM	75.8	72.3	72.6	12.5	11.0	10.3	11.5	12.4	13.3	2748	4107	4235
E&P	74.0	72.9	76.1	11.3	11.5	9.4	14.5	11.5	10.1	311	572	724
PB	79.8	76.2	76.9	16.7	11.2	11.2	3.5	7.3	9.7	114	206	277
Op	77.0	72.7	74.1	13.0	14.1	11.1	9.7	8.5	10.0	483	752	1110
Ac	80.1	76.5	78.6	14.6	12.8	9.6	5.3	6.7	7.2	226	298	332
Astron	78.0	73.9	75.7	12.1	9.9	10.3	9.8	12.8	10.9	396	710	643
Misc.	84.9	81.1	81.3	10.6	9.7	9.3	4.5	4.9	5.8	2556	2485	3552
Total[e]	78.3	74.2	74.6	11.9	10.9	10.3	9.6	10.9	11.5	10451	14286	16612
Med. age	38.3	37.5	37.0	41.9	42.9	43.7	34.2	34.2	34.9			

[a] Table presents data for all ages; data are available by five-year age cohorts.

[b] Subfield abbreviations used: A&R, astrophysics and relativity; AME, Atomic, molecular and electron; EP, elementary particle; NP, nuclear; P&F, plasmas and fluids; CM, condensed matter; E&P, earth and planetary; PB, physics in biology; Op, optics; Ac, acoustics; Astron, astronomy; Misc, miscellaneous.

[c] Some percentages do not add up to 100 because of 3.7 percent in 1970 who were in an "Other" category composed of incomplete responses and U.S.-born noncitizens.

[d] 1970 figures for plasmas are 69.0, 13.3, and 14.2 (*N*=542); 1970 figures for fluids are 68.1, 15.0, and 12.2 (*N*=576).

[e] Based on total known; five did not respond on age in 1964, 25 in 1968, and 19 in 1970.

Table II.9 shows the distribution of citizen and noncitizen groups by subfield of employment. The noncitizen group is somewhat more heavily concentrated in the so-called intrinsic subfields than in the extrinsic ones such as optics, acoustics, physics in biology, and earth and planetary physics. Some of this difference may result from age, for certain subfields tend to attract young people, and the noncitizens are a comparatively young group. The variation by subfield still occurs, however, if one controls for age by considering a single age group, for example, the 35-39 year old group in which the highest proportion of noncitizens (16.5 percent) is found. Table II.10 shows the proportion of noncitizen PhD's in this age group in each subfield. More than one fifth of the 35-39-year-old population in such major subfields as astrophysics and relativity, elementary-particle physics, and plasma physics and physics of fluids is noncitizen.

TABLE II.10 Proportion of Noncitizen PhD's, 35-39 Years of Age, in Each Subfield

Physics Subfield	Percent Foreign-Born Noncitizens
Astrophysics and relativity	25.0
Elementary Particle	22.5
Plasmas	21.9
Physics of Fluids	20.2
Nuclear	18.7
Atomic, molecular, and electron	18.6
Condensed-matter	17.2
Earth and planetary	14.9
Optics	14.5
Astronomy	14.0
Miscellaneous	10.8
Acoustics	8.5
Physics in biology	7.1
All subfields	16.5

Only about 10 percent of the non-PhD physics population in 1970 was foreign born. The small number could result from the entry of fewer non-PhD foreign physicists to the United States or to less adequate figures on foreign pre-PhD students than on foreign PhD's.

The data on foreign-born physicists do not show how many came to the United States for education or specific work experience and returned to the country of origin or the number who remained. The U.S. Department of Labor estimates indicate that some 4000 physicists have immigrated to the United States since 1949. How many had training at the time of immigration sufficient for them to be regarded as physicists, their age distribution, and the rate of return migration are not known. According to the 1970 National Register the number of foreign-born physicists is higher than the Department of Labor's estimate—about 6000. However, there are no data on when these physicists immigrated—before or after 1949, before or after becoming a physicist.

The Doctorate Record File affords data on the postdoctoral destination and activity of new PhD's in physics and astronomy from 1958 through 1970 (see Table II.11). Of the 1918 noncitizen PhD recipients, 53 percent remained in the United States and 40 percent of these went into postdoctoral study. Twenty-three percent of the noncitizen group left the United States, and these went more often into employment than postdoctoral study. The destinations of 24 percent were unknown.

TABLE II.11 Location and Activity of New PhD Physicists[a]

	Postdoctoral Study		Employment			
Citizenship	U.S.	Foreign	U.S.	Foreign	Unknown	Total
United States	1695	420	6024	152	1979	10,270
Foreign	392	139	626	301	460	1,918
						12,188[b]

[a] Data from the Doctorate Record File; U.S. Doctorates, Physics and Astronomy FY 58-70.

[b] There were 303 PhD's on whom data were incomplete, bringing the total to 12,491.

II.1.3.1.4 *Employment* Before discussing the changing employment and mobility patterns of physicists, some background information on their employment is needed to place the analyses in context. Table II.12, showing employment patterns of PhD physicists from 1964 through 1970, is repeated from *Physics in Perspective*, Volume I, page 832, for it presents data on several topics that we will discuss further—type of employer, subfield of employment, and changes in these with time.

Much of the discussion that follows deals with comparisons of those in academic and nonacademic employment. When relevant, the nonacademic group is subdivided, as in Table II.13.

The distribution of academic and nonacademic physicists among subfields shows many similarities (see Table II.14). Exceptions are optics and condensed matter, which have somewhat higher percentages of nonacademic than academic physicists, and elementary-particle physics, which is principally university-based. A substantial number (23 percent) of the nonacademically employed PhD's work in general physics or other sciences.

TABLE II.12 Changes in Employment Patterns of PhD Physicists, 1964—1970

Physics Subfield	Total Population (excluding nonrespondents)			College or University			Industry			Government			Research Center			Other Institutions		
	1964	1968	1970	1964	1968	1970	1964	1968	1970	1964	1968	1970	1964	1968	1970	1964	1968	1970
Astrophysics and relativity	63	123	252	0.83	0.81	0.73	0.03	0.02	0.07	0.02	0.06	0.09	0.05	0.07	0.09	0.08	0.04	0.02
Atomic, molecular, and electron	649	998	1,065	0.46	0.51	0.54	0.22	0.21	0.23	0.11	0.12	0.09	0.17	0.11	0.10	0.03	0.04	0.04
Elementary-particle	889	1,289	1,409	0.54	0.75	0.76	0.02	0.02	0.02	0.05	0.03	0.03	0.24	0.19	0.17	0.05	0.02	0.02
Nuclear	1,277	1,794	1,782	0.41	0.50	0.52	0.08	0.10	0.10	0.07	0.08	0.06	0.39	0.27	0.25	0.05	0.05	0.07
Plasmas and fluids	707	930	1,104	0.31	0.44	0.48	0.22	0.23	0.20	0.08	[illegible]	0.09	0.35	0.21	0.19	0.04	0.03	0.03
Condensed-matter	2,707	4,064	4,157	0.36	0.43	0.43	0.38	0.33	0.35	0.08	[illegible]	0.09	0.14	0.11	0.09	0.04	0.03	0.03
Space and planetary	309	567	712	0.31	0.38	0.38	0.22	0.20	0.23	0.22	0.23	0.22	0.15	0.13	0.13	0.10	0.06	0.04
Physics in biology	111	203	274	0.41	0.47	0.46	0.13	0.11	0.11	0.17	0.10	0.09	0.04	0.07	0.09	0.25	0.25	0.24
Optics	477	743	1,078	0.20	0.25	0.27	0.51	0.52	0.50	0.09	0.09	0.10	0.15	0.06	0.08	0.05	0.06	0.05
Acoustics	223	295	324	0.30	0.37	0.31	0.37	0.37	0.41	0.13	0.15	0.19	0.11	0.05	0.05	0.09	0.05	0.05
Other	2,528	2,383	3,457	0.51	0.56	0.58	0.23	0.22	0.21	0.08	0.08	0.07	0.12	0.07	0.07	0.06	0.07	0.08
TOTAL PHYSICS	9,940 [a]	13,389 [b]	15,614 [c]	0.43	0.49	0.50	0.24	0.23	0.24	0.09	0.09	0.09	0.19	0.14	0.12	0.05	0.05	0.05
Astronomy	393 [d]	689 [e]	634 [f]	0.58	0.63	0.59	0.05	0.07	0.07	0.17	0.16	0.18	0.12	0.09	0.11	0.08	0.05	0.05
TOTAL	10,333	14,087	16,248	0.43	0.50	0.51	0.24	0.23	0.23	0.09	0.09	0.09	0.19	0.13	0.12	0.05	0.05	0.05

[a] Nonrespondents = 119.
[b] Nonrespondents = 211.
[c] Nonrespondents = 373.
[d] Nonrespondents = 123.
[e] Nonrespondents = 224.
[f] Nonrespondents = 383.

TABLE II.13 Percentage Change in PhD Employment, 1964-1970

Employer	1964	1970	Percentage of Yearly Change[a]
College and university	4,478	8,223	0.139
Industry	2,450	3,805	0.092
Government	917	1,468	0.100
Research center	1,930	1,912	-0.001
Other[b]	558	840	0.084
TOTAL	10,333	16,248	0.095

[a] 1970-1964/1964/6.

[b] Includes high school, junior college, hospital, and other nonprofit organizations.

TABLE II.14 Distribution among Subfields of Academically and Nonacademically Employed PhD's in 1970

Physics Subfield	Employment (%)	
	Academic	Nonacademic
Condensed-matter	22	29
Optics	4	10
Atomic, molecular, and electron	7	6
Plasmas and fluids	6	7
Nuclear	11	11
Elementary-particle	13	4
Other	8	23
Earth, planetary, astrophysics and relativity, and astronomy	9	10
Teaching of physics	20	0

Figure II.1 depicts the distribution among subfields of PhD physicists employed in industry, government, and research centers in 1970. Major emphasis in industry is on optics and condensed matter, and in research centers, on nuclear physics, elementary-particle physics, and plasmas and fluids. Most nonacademically employed physicists in earth and planetary physics, astronomy, and astrophysics and relativity work for the government.

Regardless of where a physicist is employed, at least part of his work generally is supported by the federal government. In 1970, 9491 PhD physicists who responded to the National Register

(59.4 percent of the total respondents in physics) acknowledged government support.* Twenty-one percent of these physicists were employed by the government or by federally funded research and development centers; however, 52 percent of those in nonfederal employment received some government support, as Table II.15 indicates.

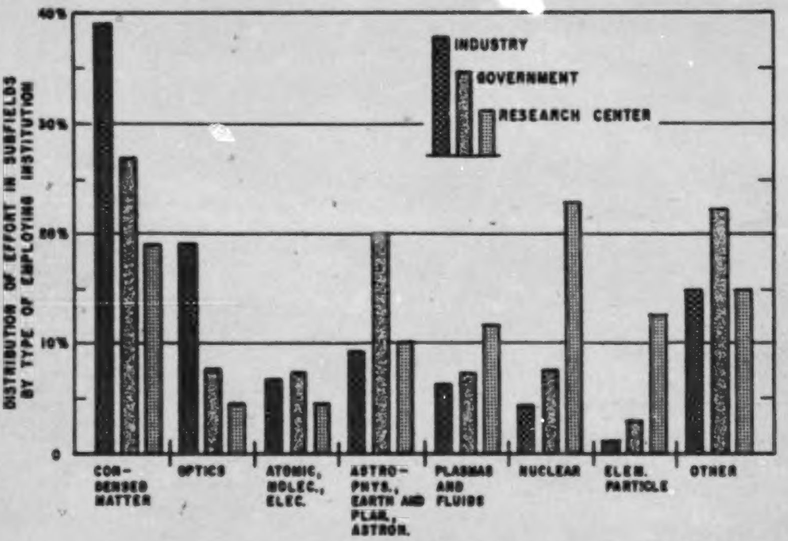

FIGURE II.1 The distribution of nonacademic PhD employment by subfield.

The fraction of the physics population receiving federal support decreased by 11.5 percent between 1968 and 1970, although the absolute number receiving such support increased by 4 percent. The federal programs in which physicists work appear in Table II.16. Defense, atomic energy, and space programs account for three fourths of the funds acknowledged by Register respondents. The DOD, AEC, and NASA account for 91 percent of the federal expenditures in basic and applied research in physics. The distribution of federal obligations for basic and applied research in physics is shown in Table II.17 for comparison with the distribution among federal programs of support acknowledged by Register respondents shown in Table II.16. The acknowledgments of support suggest that physi-

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*The 634 astronomers shown in Table II.12 are not included in the analyses and comparisons of funding. Although some physicists working in astrophysics and relativity and earth and planetary physics may receive funds under federal astronomy programs, the distortion in manpower figures is likely to be small in comparison with the distortion in support figures that would be introduced by inclusion of federal obligations in astronomy.

TABLE II.15 Fraction of PhD Physicists Not Employed by the Federal Government Who Acknowledged Some Federal Support

Employer	Percent Indicating Federal Support
University	56
Industry	42
Other nongovernment	61
Total nongovernment	52

TABLE II.16 Sources of Federal Support Acknowledged by PhD Physicists in 1970[a]

Program	Percentage of Funds Supporting Work in Physics (%)		No. of PhD's[b]	
Defense	32		3,861	
Atomic energy	27		3,228	
Space	15		1,854	
Subtotal, defense/space		74		8,943
Education	8		1,011	
Health	4.5		541	
Housing, public works, transportation, and urban development	2.5		307	
Agriculture, natural resources, and rural development	2		260	
Other	8		946	
Subtotal, nondefense/ space		25		3,065
TOTAL			12,008	12,008

[a] Excludes astronomy.

[b] Includes multiple responses. Of 15,987 PhD's, 9491 reported at least one source of government support.

TABLE II.17 Federal Obligations for Basic and Applied Research in Physics[a]

Agency	Percentage Distribution of $613 Million Obligated, FY 1970 (%)	
DOD	30	
AEC	38	
NASA	23	
Subtotal, defense/space		91
NSF	5.5	
Other	3.5	
Subtotal, nondefense/space		9

[a] Source of data: *Federal Funds for Research, Development, and Other Scientific Activities.* National Science Foundation (NSF-70-38) (Volume 19).

TABLE II.18 Acknowledgments of Federal Support by Subfield

Physics Subfield	Percentage of PhD's Acknowledging Support from the Government (%)
Plasmas	86
Acoustics	78
Nuclear	74
Elementary-particle	69
Earth and planetary	81
Astrophysics and relativity	57
Physics of fluids	73
Optics	61
Atomic, molecular, and electron physics	61
Condensed matter	55
Miscellaneous (including teaching)	46
All subfields	61

cists are finding work in fields other than the traditional ones of defense and space. It is not clear in the Register data which program, education or other, a respondent supported by the NSF would indicate. The major finding from this comparison is that support from agencies other than those concerned with defense and space, although amounting to only 9 percent of the federal obligations for physics research, affects one fourth of the physicists supported, at least in part, by government programs.

Physicists in some subfields receive more federal support than those in others, as Table II.18 indicates.

Another source of information on the support of physics research is acknowledgments of support in published journal articles. These data are presented and discussed in Chapter III, especially in Tables III.2—III.6 and Figure III.1. This Chapter explores in detail the support of physics in research by government, industry, and universities.

Multiple employment is a characteristic of professional life. For the academically employed physicist its economic benefits cannot be overlooked, and it generally offers a point of contact between academic and nonacademic institutions that is valuable. Register data suggest that such interaction has been sharply reduced between 1968 and 1970, presumably as a consequence of increasingly stringent economic conditions. In 1968, some 400 university-based PhD's reported additional employment outside the university and 400 nonacademically employed PhD's reported a secondary job, usually in a university. By 1970, these numbers had decreased by about a factor of 2. Since the questionnaire does not define additional employment, the data are likely to represent a lower bound on personnel interchanges— those individuals for whom a second job represents a substantial commitment of their total professional obligations.

Funds generally regarded as discretionary have been severely affected by the economic situation; consequently, there has been a marked decrease in summer employment of faculty and exchanges of personnel among academic and nonacademic institutions. Such exchanges, which are highly cost effective in terms of productivity, are highly vulnerable to budget expediency.

Professional employment includes a number of specific work activities— for the physicists, principally research, teaching, and the management of research and development. Rarely does a single activity adequately describe the work of a particular physicist. The individual ordering of such activities varies with institutional setting and over time with the development of a professional career. The following statistical analysis provides a description of the major work activities of physicists in the socioeconomic circumstances that prevailed in the late 1960's.* Taken together with the preceding data on employment, this analysis provides a quantified picture of the traditional employment of a physicist. In interpreting this picture and assessing its relevance to future projections, one must take into consideration that what a physicist

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*We are indebted to Hugh Odishaw for a critical discussion of this point.

TABLE II.19 Distribution of Work Activities of Academically Employed PhD's

Primary Work Activity	Secondary Work Activity (%)							Distribution of Primary Work Activity[a] (%)
	Basic Research	Applied Research	Development	Mgmt. R&D	Mgmt. Other	Teaching	Other	
Basic research	4.85	2.44	0.60	1.11	0.20	26.5	2.36	38.4
Applied research	0.48	0.22	0.25	0.25	0	1.9	0.14	3.25
Development	0.06	0.03	0.01	0.01	0.01	0.02	0	0.16
Management, R&D	0.73	0.39	0.01	0.11	0.25	1.17	0.11	2.75
Management, other	0.61	0.10	0.01	0.49	0.42	2.71	0.10	4.43
Teaching	35.4	4.74	0.15	0.82	4.68	3.26	1.83	50.9
Other	0.11	0.02	0	0.01	0.03	0.10	0.15	0.43

[a] N = 8032.

TABLE II.20 Distribution of Work Activities of Nonacademically Employed PhD's

Primary Work Activity	Secondary Work Activity (%)							Distribution of Primary Work Activity[a] (%)
	Basic Research	Applied Research	Development	Mgmt. R&D	Mgmt. Other	Teaching	Other	
Basic research	6.05	13.0	1.16	4.86	0.17	2.3	4.77	32.3
Applied research	8.35	4.88	7.9	5.1	0.13	1.0	3.92	31.2
Development	0.15	2.28	0.88	0.52	0.06	0.05	0.46	4.54
Management R&D	3.48	9.23	2.14	2.18	2.4	0.39	2.27	21.81
Management, Other	0.10	0.2	0.2	1.45	0.59	0.3	1.16	4.04
Teaching	0.29	0.18	0	0.06	0.18	0.37	0.22	1.29
Other	0.51	1.09	0.39	0.4	0.33	0.15	1.73	4.61

[a] $N = 7864$.

can do may be qualitatively different from a statistical picture of what he currently does. Such differences could become significant in the 1970's. Future changes, of course, cannot be quantified, but one can get some insight into the modes of change by examining patterns of mobility of physicists, discussed in detail in II.1.3.2.

Respondents to the National Register specify their primary and secondary work activities, and the aggregation of these responses provides a more detailed picture of the distribution of activity characterizing the employment of a physicist. The pattern of activity for all age groups taken together appears in Tables II.19 and II.20. A single work activity adequately describes the professional employment of but 13 percent of the physicists. In academia research generally is combined with teaching; in nonacademic settings basic research typically is combined with applied research or development, and both types of research are often combined with the management of research and development.

A major difference between PhD's working in academic institutions and those in other types of employing institutions is, of course, involvement in teaching. More than four fifths (84 percent) of the academically employed PhD's had teaching responsibilities, and 69 percent combined teaching and research. Research was a major work activity in all employment settings. As adding the first two columns in Table II.21 will show, approximately 85 percent of the PhD's in industry, government, and universities reported some involvement in research. An even higher percentage, 94 percent, of those working in federally funded research and development centers was engaged in research. Among the PhD's working in other types of institutions (5 percent of all PhD's), 70 percent had research responsibilities.

Figure II.2 presents a comparison of the research involvement of physicists in various types of nonacademic employment.

Emphasis on basic research in the universities and research centers has remained essentially constant since 1964; however, basic research in industry and government, always a relatively small fraction of the total activity of such institutions, has declined further, as shown in Chapter 12 of *Physics in Perspective,* Volume 1, Figures 12.24 and 12.25. Thus basic research is becoming increasingly isolated in the universities and research centers.

If the university population is subdivided into those who are primarily research oriented and those who are primarily oriented toward teaching, the pattern indicated in Table II.22 and Figure II.3 results. Although minor fluctuations in percentage must be interpreted with care, the data suggest a shift toward more research-oriented activities between 1964 and 1968 and a reverse shift back to teaching between 1968 and 1970. The university adjusted to the changing research climate by slightly altering its work activities. It is doubtful that such flexibility will be possible in the future, with projected decreases in both university teaching and research functions.

The priorities assigned to the various activities that comprise a physicist's professional life change over time. The emphasis on basic research that characterizes the early years gives way to

TABLE II.21 Research[a] and Other[b] Activities of PhD Physicists in 1970 by Employer

Employer	Research and Development	Research and Development and Other	Other Only	Total
University	720 (0.09)	6008 (0.74)	1304 (0.13)	8,032
Industry	1789 (0.48)	1411 (0.37)	533 (0.15)	3,733
Government	573 (0.40)	658 (0.44)	201 (0.16)	1,432
Research center	932 (0.50)	828 (0.45)	116 (0.05)	1,876
Other	231 (0.28)	345 (0.44)	247 (0.28)	823
Total[c]	4245 (0.26)	9250 (0.58)	2401 (0.15)	15,896

[a] Research includes basic research, applied research, and development.

[b] In the university, other refers predominantly to teaching; in nonacademic employment, other refers predominantly to management.

[c] Totals may vary somewhat from earlier employer totals because a small number of people did not respond to the work activity question.

TABLE II.22 Research and Teaching Orientations in Universities, 1964–1970 (%)

Orientation	1964		1968		1970	
Research oriented	40		47		44	
Research and other		14		16		15
Research and teaching (research primary)		26		31		28
Teaching oriented	59		51		55	
Teaching and research (teaching primary)		38		37		40
Teaching and other		21		14		15

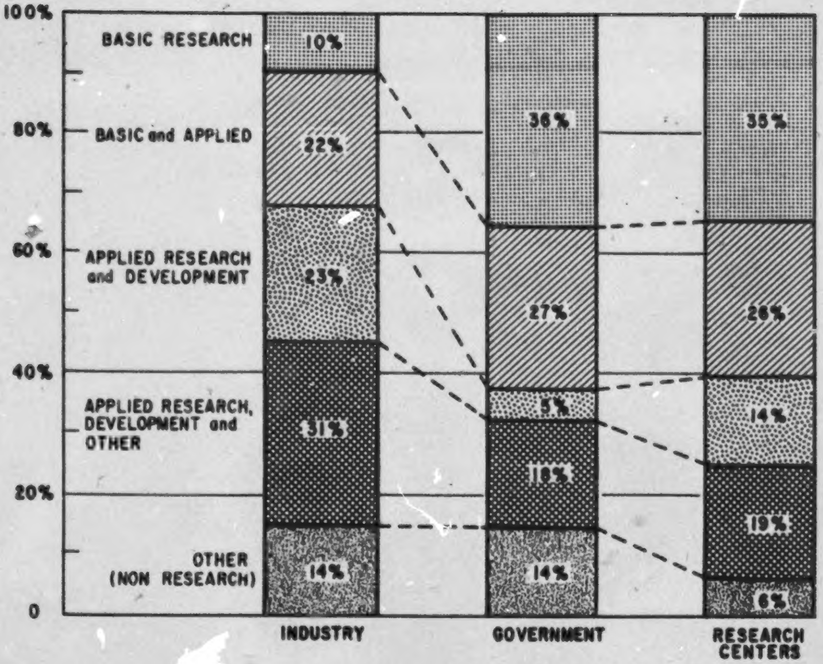

FIGURE II.2 The work activities of nonacademically employed PhD physicists in 1970.

increasing management responsibilities. In universities the combination of research and teaching shifts toward teaching and management, and in nonacademic institutions a career is likely to move from basic research into applied research and development, then into the management of research and development, as illustrated in Table II.23. The data in the Table are based on respondents to both the 1968 and 1970 Registers who remained in the same type of employing institution, a sample of approximately 70 percent of the total 1970 Register population. Comparison of the 1968 and 1970 combined work activity for this relatively stable group shows that the changes in such activity follow the age gradients implied by the data of Table II.23.

TABLE II.23 Median Age in 1970 and Distribution of Combined Work Activities of PhD Physicists[a]

Combined Primary and Secondary Work Activities	University Percent (N = 5742)	University Med. Age	Industry Percent (N = 2365)	Industry Med. Age	Government Percent (N = 952)	Government Med. Age	Research Center Percent (N = 1268)	Research Center Med. Age
Basic research	2.9	30.5	2.3	35.9	6.9	38.8	5.6	38.5
Basic and applied research	2.5	32.0	19.3	36.5	23.4	37.0	15.3	37.8
Applied research and development	0.4	31.3	20.0	37.5	4.6	42.5	8.5	38.6
Research and teaching	71.0	36.8	1.3	38.2	3.9	37.7	2.7	37.7
Research and management	3.5	43.5	33.5	41.8	33.2	42.6	20.9	43.1
Management of research and development	0.1	44.5	2.4	46.2	3.2	46.5	1.4	46.9
Teaching only	3.1	44.2	0		0		0	
Management and teaching	10.9	45.9	0.4	46.5	0.5	49.5	0.4	51.5
Other management (than R&D)	0.6	51.2	0.8	47.5	0.4	49.5	0.1	34.5
Other combinations	5.0	42.5	19.9	43.2	22.8	44.9	11.3	38.4
All work activities		37.9		40.0		41.4		40.0

[a] The samples includes only respondents to both the 1968 and 1970 National Register surveys who remained in the same type of employing institution.

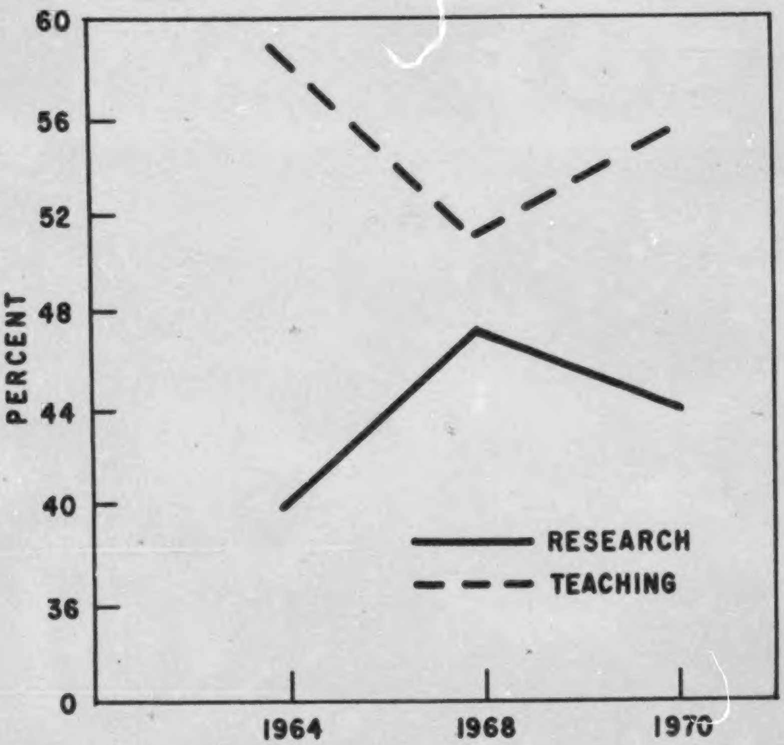

FIGURE II.3 Variations in teaching and research orientation in universities, 1964—1970.

II.1.3.2 *Subfield Mobility*

The distribution of young PhD's among subfields closely resembles that of graduate students and university-based physicists in general, as Table II.24 shows. This comparison reflects a pattern of early choice that persists despite the change of status from graduate student to PhD. By age 30, 44 percent of the physics PhD's have left university study or employment and have adapted their interests to new environments. Within this pattern of persistent interests, however, substantial mobility among subfields occurs. The subfield transition matrix in Table II.25 depicts this mobility. The striking feature is that 25 percent of the 971 who remained in the eight major subfields changed from one of these subfields to another.

In addition to mobility among subfields, there also is a substantial flow into other areas, for example, teaching, computer science, and other fields. Seventy percent of the 178 PhD's moving into other areas went into general physics and teaching; the other 30 percent (4.3 percent of the degree mobile cohort) went into other sciences. The imbalance between outward and internal

TABLE II.24 Subfield Distribution of Graduate Students, Young PhD's and University-Based PhD's

Physics Subfield	Graduate Students[a] *N* = 9000	PhD's <30 *N* = 1813	University-Based PhD's *N* = 8208
Condensed-matter	27.3%	27.0%	21.8%
Elementary-particle	15.7	13.8	13.0
Nuclear	14.8	11.4	11.3
Atomic, molecular, and electron	7.4	8.0	7.0
Plasmas and fluids	3.4	6.4	6.4
Optics	2.6	4.8	3.4
Physics in biology	1.3	2.1	1.6
Acoustics	1.1	1.4	1.2
Astronomy and astrophysics	4.9	7.9	6.7
Other	21.5	17.0	26.4

[a] Source of these data is American Institute of Physics publication No. R-207.2.

mobility could have been biased by the selection of a sample population consisting only of physicists; however, a longitudinal analysis of the entire PhD population between 1960 and 1966 indicates that this trend is not artificial.

New PhD's who leave the university are more likely to change subfields than those who remain. In our sample which includes 44 percent of all physics and astronomy PhD's granted in 1968 and 1969, the 466 young people who left the university were 36 percent more likely to change subfield than the 614 who remained. Of those who remained, about 250 were probably postdoctorals, a status often used for advanced specialization rather than diversification.

The pattern of youthful interest in physics subfields differs significantly from that of the physics population as a whole. These differences are reflected in a comparison of the age distributions of the various subfields, a comparison that is facilitated by constructing a set of appropriate cohort ratios. Table II.26 presents a comparison of the ratio of the under 30 cohort with the 40-45 cohort.* The variations from average among the subfields illustrates a distinct pattern of youthful interests compared with mature interests, which is depicted in Figure II.4. The general persistence of this pattern since 1964 also is indicated in Figure II.4, although some changes are evident. Interest in physics in biology has increased, and that in elementary-particle physics, which still attracts the young, clearly is decreasing. Interest

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*The analysis is not sensitive to the particular choice of a mature cohort. A rank ordering of the subfields by median age illustrates the trend.

TABLE II.25 Subfield Transition Matrix for Physicists Receiving the PhD between 1968 and 1970[a,b]

Subfield in 1968	Subfield in 1970 AME	EP	NP	P&F	CM	PB	Op& Ac	A&R, E&P	Other	Total 1968
AME	44	1	3	5	15	4	14	4	23	113
EP	0	109	10	2	7	0	3	10	26	167
NP	5	5	107	4	11	2	2	6	23	165
P&F	2	1	0	52	6	0	5	3	10	79
CM	11	2	6	10	272	6	34	4	65	410
PB	1	0	3	0	1	12	2	0	3	22
Op&Ac	6	0	0	0	7	0	29	1	9	52
A&R,E&P	2	1	2	2	4	0	8	108	19	143
Other	1	4	2	1	10	2	8	4	70	102
Total 1970	72	123	133	76	333	26	102	140	248	1251[c]

[a] Subfield abbreviations used are the same as those identified in Table II.9, footnote *b*.

[b] Age characteristics of the sample: lower quartile 28.6; median 30.2; upper quartile 32.9. Mobility with regard to type of employing institution: mobile 37 percent; static, academic 49 percent; static, nonacademic 14 percent.

[c] There were 604 additional respondents whose responses on subfields were incomplete.

in astronomy and earth and planetary physics has increased considerably, and that in plasmas and fluids has diminished. The overall regularity and persistence of the interest profile suggests that the emphases of the previous decade do not persist in the subfield age distribution; subfield mobility effectively dissipates fluctuations in fashion.

The profile of youthful interest depicted in Figure II.4 is similar to the profile of foreign involvement in U.S. physics discussed in Chapter 8 of *Physics in Perspective*, Volume 1 and shown there in Figures 8.9 and 8.10. The concentration of foreign-born physicists varies with subfield in the same way as the concentration of young physicists and the median age of the foreign group is inversely correlated with concentration; that is to say, subfields that attract many foreign physicists also attract principally young foreign physicists.

A significant feature of the data of Table II.26 is that the relative concentration of young PhD's is not correlated with differential subfield growth. Although this finding may reflect to some extent limitations on the available options in graduate education, it is clear that the rapid growth of astrophysics and relativity, earth and planetary physics, and optics results from intellectual mobility at all ages. Optics provides a representative example.

TABLE II.26 Age Characteristics of PhD Physicists by Subfield, 1964 and 1970[a]

	1970 Population					1964 Population			
Subfield	Median Age	Total	≤29	40-44	Ratio <29/40-44	Median Age	Total	Ratio <30/41-45	Growth Total 70/Total 64
PB	37.2	274	39	28	1.39	40.6	111	0.40	2.46
EP	34.2	1,407	250	187	1.33	34.1	889	2.70	1.59
Astron	35.0	633	106	80	1.32	37.4	392	1.45	1.61
A&R	34.7	250	40	34	1.18	34.7	63	1.72	3.97
AME	35.3	1,065	145	146	1.02	36.5	649	1.20	1.65
CM	36.4	4,152	489	664	0.74	36.7	2707	1.07	1.54
E&P	37.4	712	85	119	0.73	38.1	309	0.78	2.30
NP	37.8	1,782	206	315	0.65	37.3	1277	0.90	1.40
P	36.0	567	63	96	0.66	36.7	706	1.26	1.56
F	38.1	534	51	92	0.56				
Op	38.7	1,077	86	159	0.54	40.3	477	0.625	2.26
Ac	40.1	324	26	49	0.53	42.2	223	0.460	1.45
All subfields	37.4	12,877	1589	1971	0.806	38.2	7803	1.15	1.65

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[a] Subfield abbreviations are those indicated in Table II.9, footnote *b*.

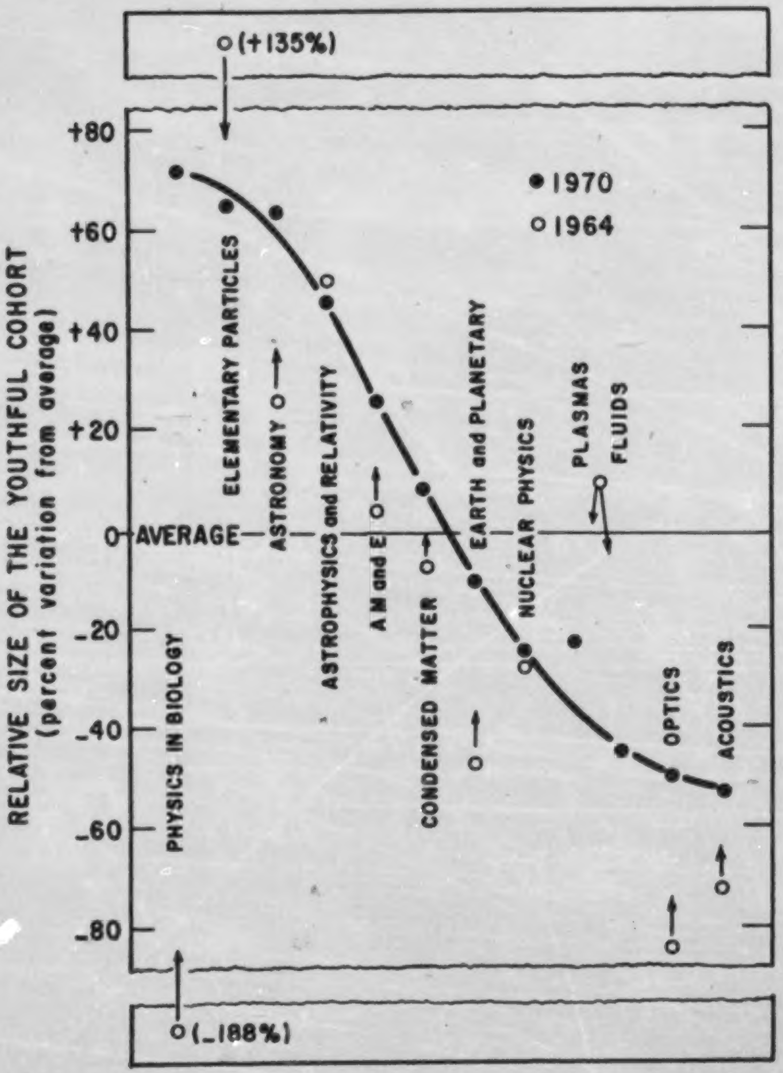

FIGURE II.4 Comparison of youthful and mature interest in various subfields of physics— the size of the 30 cohort compared with the 40-45-year-old cohort.

Between 1964 and 1970 approximately 700 PhD's went into optics. (The increase of 600 shown by Register data is about 85 percent of the total.) In this same interval the Doctorate Records File shows 80 new PhD's in optics. To have met the actual growth rate with physics graduate students (assuming 100 percent retention of new doctorates in the subfield) would have required an 875 percent expansion of university facilities as well as a promotional campaign to reverse what is apparently a rather well-established motivational pattern. There is no evidence to suggest that optics received any special external stimulation, such as increased federal support during this period of growth.

Table II.27 shows changes in optics manpower between 1968 and 1970. The major interchanges with optics were with atomic, molecular, and electron physics and condensed matter, subfields with which considerable overlap might be expected. However, a nontrivial interchange with all subfields is evident. Among established PhD's only about 300 remained identified with optics in both years; 471 entered from other subfields and another 303 left. The static component in the subfield is relatively small compared with the mobile population and the net change in optics is the difference between two large numbers. All ages participated; the median age of inward mobile components correlates roughly with the median age of the subfield of origin. An examination of simultaneous changes in type of employing institution among optics PhD's between 1968 and 1970 provides no evidence that external circumstances had any particular effect on manpower interchanges in the subfield. Of the 289 established PhD's who worked continuously in optics, 10 percent changed type of employing institution; of the 471 PhD's who entered the subfield, 13 percent changed type of employing institution. Taken together, 11.6 percent of the 1970 optics manpower had made a change in type of employing institution since 1968, the same percentage as for the overall physics population. The movement into optics, then, is largely an *in situ* process.

The pattern of subfield interchanges for all PhD's in the 1970 Register for whom adequate responses were also available in 1968 appears in Table II.28. The sample amounts to 80 percent of the PhD's in the 1970 Register, an estimated 65 percent of the total U.S. physics PhD population. On the basis of this classification scheme (an 11 by 11 matrix), some 34 percent of the physics PhD's changed the subfield in which they were working between 1968 and 1970. Some subfields had a higher proportion of mobile PhD's than others, as Table II.29 shows. This Table ranks the subfields according to the inward mobile fraction of the 1970 totals. In some instances, the apparent variation results from the diversity of specialties that comprise a given subfield. In condensed matter, for example, a major change in scientific interest from superconductivity to high-pressure physics would not show in the matrix of Table II.28. In contrast, elementary-particle physics, another subfield of low mobility, is defined by only six specialties—hadrons, leptons, photons, high-energy cosmic rays, quantum field theory, and other. This brief list adequately describes the interests of 84 percent of the 1970 elementary-particle physics population. The actual magnitude of the mobility inferred from such

TABLE II.27 Changes in Optics Manpower[a] between 1968 and 1970

Subfield in 1968 or 1970[b]	New PhD's		Doctorates before 1968			
	Entrants	Leavers	Entrants	Med. Age	Leavers	Med. Age
Op	19		298	41.6		
AME	14	6	92	38.7	60	43.0
EP	2	0	10	34.0	4	35.5
NP	2	0	26	45.2	5	51.5
P&F	4	0	27	37.5	5	36.2
CM	25	5	211	41.3	95	39.2
E&P	4	0	11	41.5	19	39.9
PB	1	0	8	47.5	6	48.5
Ac	0	0	7	41.5	2	36.5
Astron	0	1	11	33.5	4	41.5
Gen. phys. & teach.	7	4	47	41.0	65	47.5
Other sciences	1	1	21	44.0	38	47.3
1970 total	79		769	40.9		
Other subfields:						
Entrants	60		471			
Leavers		17			303	
1968 total		36			601	42.4

[a] Based on respondents to both the 1968 and 1970 National Register surveys. Such respondents amount to 64 percent of new PhD's and about 65 percent of all established PhD's.

[b] Subfield abbreviations used are those indicated in Table II.9, footnote *b*.

a transition matrix depends, of course, on the dimensionality of the matrix; the finer the distinctions, the greater the numerical magnitude of the mobility.

Table II.30 presents a comparison of established PhD's with the degree mobile cohort and shows that established PhD's are about as likely to change subfields as are new PhD's. More scientists move away from the discipline-intensive physics subfields than enter; the flow to other sciences amounts to 3 percent for established PhD's compared with 4 percent in the young cohort.* The higher

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*A 10 percent flow of new physics and astronomy PhD's to other fields is reported by the Office of Scientific Personnel in 1969 (OSP-MS-3, April 1970). The difference results from different definitions. We have included some chemistry, earth sciences, and biosciences in physics subfields.

TABLE II.28 Transition Matrix between 1968 and 1970 by Subfield of Employment for all 1970 PhD's[a]

1970 1968	A&R	ANE	EP	NP	F	P	P&F	CM	E&P	PB	Op	Ac	As-tron	Misc	1968 Total
A&R	82 36.9	1 41.5	9 35.5	1 39.5				2 37.5	8 32.5				7 30.0	11 32.0	121 36.2
ANE	2 35.5	440 36.9	9 39.0	16 33.2	37 38.4	10 34.5	47 37.6	107 35.5	19 39.2	9 33.5	106 37.8	1 31.5	14 35.2	155 38.3	925 37.0
EP	11 35.0	15 35.5	895 34.4	65 35.9	7 34.0	3 33.5	10 33.8	25 31.0	28 33.0	2 36.5	12 33.5	6 32.5	3 29.5	140 34.0	1210 34.3
NP	6 35.5	38 33.8	54 41.8	1156 38.7	12 37.5	8 31.5	20 34.5	89 39.5	23 35.5	16 36.1	28 43.5	5 34.0	4 41.5	235 39.3	1674 38.7
F	1 55.5	17 41.0	2 31.5	6 37.5	202 40.9	13 33.5	215 40.5	45 38.7	12 34.5	2 37.5	10 36.5	4 34.5	1 29.5	52 41.2	367 39.3
P	1 35.5	12 37.8	5 41.0	6 43.5	26 33.9	330 37.2	356 36.8	14 36.5	11 41.5	1 31.5	21 35.5	1 27.5	1 31.5	29 39.9	458 37.2
P&F	2 45.5	29 39.5	7 37.5	12 40.5	228 39.9	343 36.9	571 37.9	59 37.9	23 36.2	3 33.5	31 35.5	5 33.5	2 30.5	81 40.4	825 38.1
CM	2 51.5	135 37.0	33 36.7	48 42.5	88 36.3	13 35.5	101 36.2	2634 37.1	26 38.5	25 36.2	236 39.8	38 35.4	3 47.5	478 39.9	3759 37.5
E&P	6 42.5	9 39.5	15 37.7	2 32.5	4 43.5	3 33.5	7 35.5	17 40.0	323 38.5	1 35.5	15 39.0	2 55.5	37 37.7	52 40.0	486 38.6
PB		3 51.5		22 38.5	4 35.5		4 35.5	6 45.5		112 39.0	9 47.0	6 37.5	1 41.5	17 37.5	190 39.1
Op		66 40.0	4 35.5	5 51.5	2 36.5	3 36.0	5 36.2	100 38.7	19 39.9	6 48.5	317 41.1	2 36.5	5 36.0	108 46.7	637 41.6
Ac		1 43.5		2 51.5	6 37.5	1 35.5	7 35.5	24 40.5	2 45.5	9 38.0	7 41.5	171 43.6		26 46.5	249 43.0
Astron	75 33.7	12 40.5	7 37.5	2 43.5	2 38.5	2 33.5	4 34.5	6 32.5	55 35.4	3 47.5	11 33.5	1 31.5	391 36.6	91 42.1	658 36.1
Misc	9 39.0	34 42.5	31 34.8	59 40.0	51 42.0	10 46.5	61 42.7	179 39.4	55 44.7	15 47.5	76 41.5	22 43.8	17 43.5	1327 44.2	1885 43.5
Total 1970	195	783	1064	1390	441	386	837	3268	581	201	868	237	484	2721	12698
Age[b]	31.2 35.4 40.7	32.1 37.4 44.7	31.3 34.9 40.8	33.0 38.7 45.3	33.9 39.1 45.9	32.5 36.6 42.6	33.2 37.8 44.3	32.3 37.2 43.4	32.7 38.3 45.1	33.0 38.6 47.7	33.7 39.7 47.3	34.5 40.8 50.4	31.3 36.6 44.2	34.6 42.3 49.8	32.8 38.3 45.6

[a] Subfield abbreviations used are those identified in Table II.9, footnote *b*.

[b] Lower quartile, median, and upper quartile.

subfield mobility of new PhD's is associated with the major upheaval that takes place between graduate school and postdoctoral employment.

Established PhD's change jobs from time to time, and such changes afford opportunities to undertake new scientific interests. Between 1968 and 1970, 11.9 percent of the established PhD's changed type of employing institution; Table II.31 compares the concurrent changing of subfields of the mobile physicists with interchanges of those who remained in the same type of employment. Clearly, those who change jobs are 20 percent more likely to change subfields than are those who do not. However, a substantial amount of subfield changes occur within one type of employment. Those who move into and leave universities—the major component of employment-change group— may do so as a result of the pursuit of a certain type of research, or they may redirect their interests to be compatible with a more satisfactory employment circumstance. Employment mobility produces, on the whole, no more than a 20 per-

TABLE II.29 Subfield Mobility between 1968 and 1970, Ranked According to the Inward Mobile Fraction of the 1970 Total

Physics Subfield	Inward Mobile as a Fraction of 1970 Total (%)
Elementary-particle	15.9
Nuclear	17.8
Condensed-matter	18.9
Astronomy	19.8
Plasmas and fluids	31.8
Acoustics	33.5
Atomic, molecular, and electron	43.8
Physics in biology	44.3
Earth and planetary	44.4
Astrophysics and relativity	57.9
Optics	62.6
Miscellaneous	51.2

TABLE II.30 Subfield Mobility, 1968 to 1970

PhD's	Internal Mobility among Eight Major Subfield Groupings[a]	Outgoing[b]	Incoming[b]
New	25%	14.2%	2.5%
Established	21%	10.7%	4.6%

[a] Percentage of the 8 × 8 group.

[b] Percentage of the total population.

TABLE II.31 Subfield Mobility of Established PhD's, 1968 to 1970

Type of Employing Institution	Percent	Internal Mobility among Eight Subfield Groupings	Outgoing	Incoming	Med. Age
Mobile	11.8%	25.8%	12.2%	5.0%	35.9
Static	88.2%	20.1%	10.8%	4.8%	39.8

cent enhancement of subfield mobility. The employer-mobile population is distinctly younger than the employer-static part of the established PhD population, but, as age characteristics of mobility will show, this finding suggests, if anything, an even greater enhancement of subfield mobility due to simultaneous employment mobility.

To examine the age dependence of subfield mobility, we examined data on the employer-static, established PhD's. The results appear in Table II.32. The myth of youthful intellectual mobility was unsubstantiated. If anything, it appears that the likelihood of diversification of scientific interest is correlated with professional maturation. This result was checked against Register data on an earlier interval, 1960-66. The results are shown in Table II.33. The upward trend displayed by the youngest cohort probably is a consequence of degree mobility; about 25 percent of that cohort received the PhD shortly after the survey in 1960. The pattern of subfield interchanges between 1960 and 1962 is generally comparable with that between 1968 and 1970. Although variation of mobility patterns with age is almost nonexistent in both sets of data, there were some differences in overall mobility. At the beginning of the decade there were fewer interchanges among major subfields than at the end of the decade. A balanced interchange between the major subfields and general physics and other sciences, which prevailed in the earlier period, became a discernible outflow by 1970. The actual magnitude of these changes is not large, but the trends are clear.

In regard to mobility by subfield, the data were generally similar for the two intervals. Those subfields broadly related to others are characterized by high mobility at both times; the most striking changes occurred in optics and physics in biology, two subfields of intense current interest.

An examination of the dependence of subfield mobility on type of employing institution suggests that changes with time are related to stresses on the physics community. These data appear in Table II.34. Clearly, the circumstances at the end of the 1960's have increased the subfield mobility of industrial physicists and decreased that of university physicists. The differences are not an artifact of a restricted definition of subfields, as the second column of Table II.34 shows. There mobility is estimated on the basis of an expanded matrix that takes into account teaching, general physics, and other sciences. Again data on an earlier period should be examined. In 1960-62 and 1964-1966 subfield mobility was essentially the same in all types of employing institutions; within the eight major subfields, 15 percent from 1960 to 1962, and for this same population of 4415 PhD's, 13 percent, from 1964 to 1966. The recent increase in subfield mobility among nonacademic physicists is asociated with the reordering of research priorities. Indeed, the high mobility within the industrial group suggests a veritable scrambling about for new directions together with the shift in emphasis away from basic research. In the universities, on the other hand, the erosion of research budgets has reduced the number of new projects that can be undertaken.

At any point in his career a physicist carries with him varying degrees of competence in a variety of subfields. This catalogue of subfield competence represents the accumulated experience of

TABLE II.32 Subfield Mobility of Employer Static Established PhD's by Age, 1968 to 1970

Cohort Age in 1970	Internal Mobility among Eight Subfields (%)	Outgoing (%)	Incoming (%)
27– 31	19.2	9.9	3.0
32– 36	19.2	8.8	3.9
37– 41	20.8	9.5	4.3
42– 46	21.8	10.4	4.6
47– 51	25.3	14.5	5.7
52– 61	25.2	13.6	5.3
Total (*N* = 10,013)	20.7	10.7	4.6

TABLE II.33 Subfield Mobility of Established PhD's, 1960—1962, 1964—1966

Cohort Based on Year of PhD	*N*	1960—1962 (10 × 10) Mobile[a]	1964—1966 (10 × 10) Mobile[a]
1956—1960	1366	27.1%	40.5%
1950—1955	1596	25.5%	36.7%
1949	1453	27.2%	39.4%
TOTAL	4415		

[a] Based on a 10 × 10 matrix that includes eight major subfield groupings plus teaching and other sciences.

previous mobility as well as a developing store of knowledge that can nurture new directions of scientific enquiry. An analysis of research emphasis and scientific competence of a population provides a measure of the shared interests of that population at a particular time. The distribution of subfield competence that resulted from our analysis had essentially the same features as that of subfield mobility.

The distribution of first competence for PhD's working in various subfields in 1970 is shown in Table II.35. Again the general dispersion of subfield proficiency is evident. The breadth of an individual's competence can be further explored by looking at data on second, third, and fourth competences. A typical pattern of external compared to internal competences emerges, as Figure II.5 shows. For about one fifth of the PhD's first competence was outside the subfield of employment. For lower levels of competence

TABLE II.34 Subfield Mobility of Established PhD's by Type of Employing Institution, 1968 to 1970

Institution	Internal Mobility (8 × 8)[a] (%)	Total Mobility (16 × 16)[b] (%)
University	15	31
Industry	29	42
Government	22	35
Research centers	22	32
TOTAL	20	35

[a] Based on eight major subfield groupings; see Table II.29.

[b] In the 16 × 16 matrix, optics, acoustics, astrophysics and relativity, earth and planetary physics, and astronomy are separated and the other category is subdivided into general physics, teaching, computer science, other science, and other.

the percentage was, of course, higher. The fraction of competence outside subfield of employment provides a measure of the relatedness of subfields comparable with that used in the analysis of mobility, in which internally mobile group was compared with the total in the subfield. The average external competence for the physics population was 47 percent. Some subfields were characterized by a higher percentage of external competence than others. Based on Table II.35 and like tables for successive levels of competence, a rank ordering of subfields was developed (see Table II.36). The sequence is much like that obtained for inward mobility (Table II.29). Changes in first competence form a pattern like that of subfield mobility, but the magnitude of intellectual diffusion at the level of first competence is considerably greater than it is at the level of actual scientific employment.

Thus, we can look at three demographic measures of the diffusion of knowledge in physics: subfield mobility, external competence, and first competence mobility. Taken together these measures form a consistent pattern, as shown in Figure II.6. The data in the figure can be read from left to right as follows: In, for example, plasma physics and physics of fluids, we see that inward subfield mobility accounts for 32 percent of the 1970 population (see Table II.29); concurrently, the first subfield of competence has changed for about 45 percent of the subfield; finally, individuals working in this subfield typically report about 56 percent of their competence in other subfields (see Table II.36). Although the numerical scale of these measures depends on the way in which we define a subfield, comparisons are possible within this set. Generally, the greatest inertia, or the most stable intellectual relationship, is associated with a physicist's particular subfield of research emphasis. Surrounding this subfield of research interest is a

TABLE II.35 Subfield of First Competence Compared with Subfield of Employment for All 1970 PhD's[a]

Subfield of First Competence	A&R	AME	EP	NP	F	P	P&F	CM	E&P	PB	Op	Ac	Astron	Misc
A&R	200	1	2	1	1	1	2	4	4	1	0	0	15	29
AME	1	711	23	21	11	7	18	102	22	13	117	3	16	182
EP	2	18	1187	80	2	3	5	31	15	7	16	5	4	153
NP	5	37	63	1467	14	6	20	61	34	15	32	4	3	263
F	1	9	0	2	391	17	408	66	11	3	18	6	2	62
P	0	6	4	5	11	435	446	11	11	1	8	2	6	31
P&F	1	15	4	7	402	452	854	77	22	4	26	8	8	93
CM	7	91	13	44	72	8	80	3344	26	43	200	42	11	492
E&P	4	1	4	1	4	1	5	5	446	4	12	1	51	52
PB	0	1	0	9	0	0	0	5	0	147	5	6	0	16
Op	2	106	5	12	7	6	13	181	20	10	541	5	19	146
Ac	1	4	0	2	5	0	5	29	2	4	8	213	0	30
Astron	14	2	1	0	2	0	2	5	45	1	6	0	458	63
Misc	6	35	45	72	25	26	51	159	51	18	72	21	35	1729
Total 1970	243	1016	1334	1692	543	502	1045	3964	676	263	1022	306	614	3158

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[a] Subfield abbreviations used are those identified in Table II.9, footnote *b*.

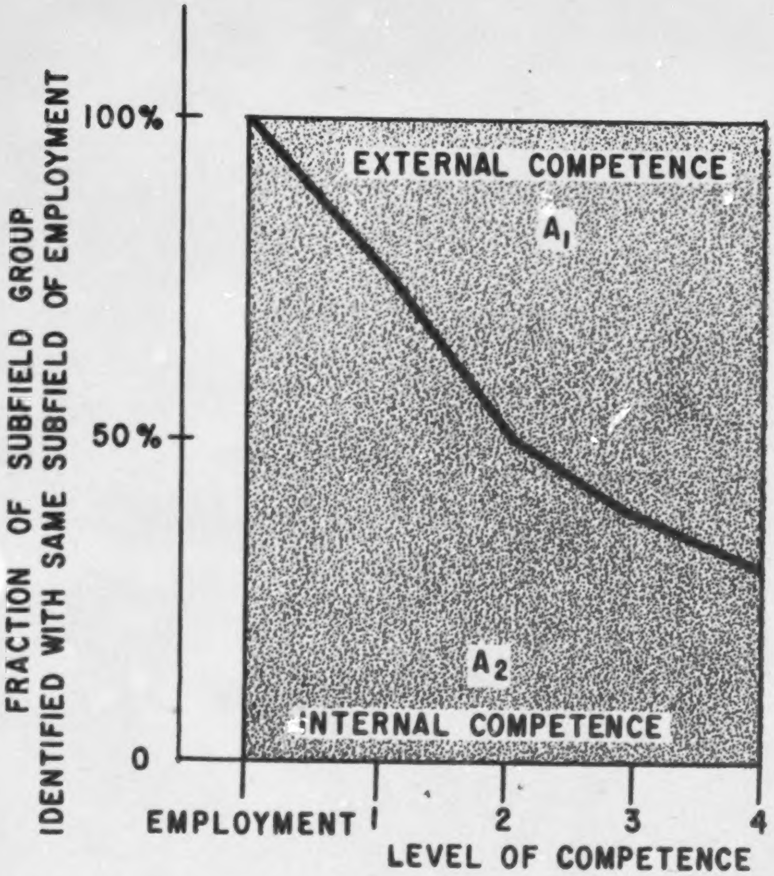

FIGURE II.5 Competence in physics subfields. For those employed in a given subfield, additional competence in that subfield is proportional to A_2, and competence in other subfields is proportional to A_1. The example above is the average for PhD physicists.

TABLE II.36 External Competence of PhD's by Subfield, 1970

Physics Subfield	External Competence (%)
Condensed-matter	27
Elementary-particle	40
Nuclear	43
Earth and planetary	51
Plasmas and fluids	56
Atomic, molecular, and electron	57
Astrophysics and relativity	60
Acoustics	62
Optics	65
Physics in biology	70
Average	47

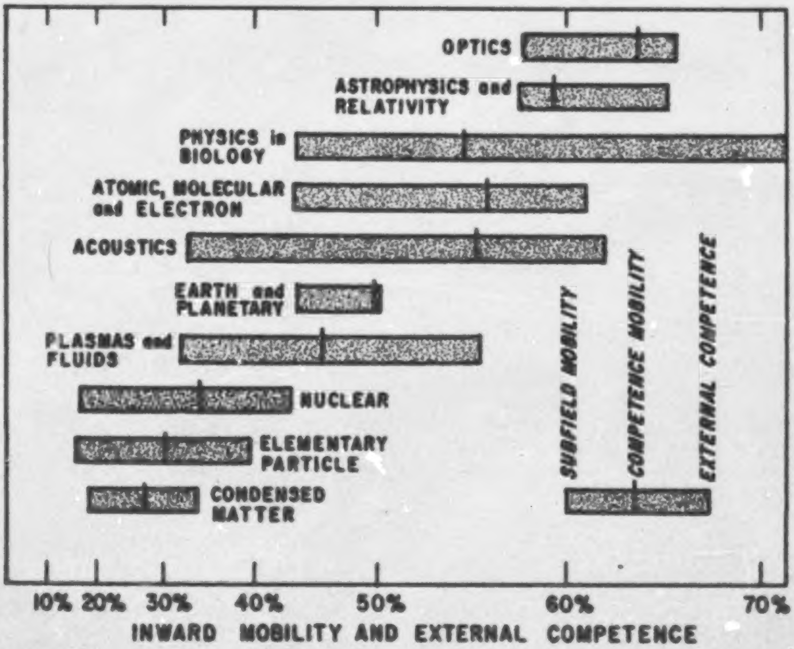

FIGURE II.6 The comparison of inward mobility of employment subfield, subfield of first competence, and the degree of external competence for physics. The scale is linear in the ratio of external to internal relatedness.

radius of competence in other subfields. Changes in the catalogue of competence are both extensive and frequent compared with changes in research activity. If the pattern of demographic diffusion (Figure II.6) is compared with the pattern of extrinsic versus intrinsic relationships among subfields developed on the basis of scientific criteria (see *Physics in Perspective*, Volume 1, Chapter 5), a remarkable unity of scientific judgment and scientific behavior is evident.

II.1.3.3 *Non-PhD Physicists*

More than half (55 percent) the non-PhD physicists work in industry and government in jobs related to applied research and development. Thirty percent are engaged in teaching, with the majority of these teachers employed by high schools and two-year colleges. Non-PhD physicists are qualified for inclusion in the National Register by a bachelor's degree or its equivalent and a minimum of two years' professional experience in physics. Sixty percent of the non-PhD group has a master's degree, and 74 percent belong to professional societies, usually one of those represented by the AIP. Thus, the non-PhD's in the National Register population are closely identified with physics through education, experience, and membership in professional associations, and this identification is made by the AIP on an individual basis. We shall examine the relationship of this population to physics-related employment and consider its principal demographic characteristics.

II.1.3.3.1 *The Physics Labor Force and the Non-PhD Physicist*

Of a total of about 1.7 million scientists and engineers in the United States, approximately one third is scientists and two thirds are engineers. The Bureau of Labor Statistics (BLS) conducts an ongoing series of employer surveys of this population. A stratified sample of employers is drawn from a universe of 500,000 establishments employing 33 million workers. What a physicist is, as distinct from a chemist, metallurgist, geoscientist, or other physical scientist, is the decision of the responding employer, who is instructed to count only those "who are actually engaged in scientific work at a level which requires a knowledge of the physical sciences equivalent to that acquired through completion of a four-year college course with a major in one of the physical science fields, regardless of whether they hold a college degree."

The employment distribution by BLS occupational sector of the physicists in the BLS survey appears in Table II.37. Based on the assumption that the PhD's in the Register physics population are likely to be among those employed in physics, the second column of Table II.37 distributes the estimated total PhD physicists according to BLS categories. The estimated employment of non-PhD physicists, the third column in this table, results from the difference between BLS population and Register PhD physics population.*

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*Since estimates of the PhD population are based on individual responses from 83 percent of the estimated physics PhD universe, the uncertainties in this part of the calculation are regarded as negligible.

TABLE II.37 Estimated Total Physics Labor Force, 1970

BLS Occupational Sector	BLS Physicists[a]		PhD's[b]		Estimated BA (or equivalent) Non-PhD's[c]	
	Number	Percent	Number	Percent	Number	Percent
University	21,200	44	11,800	59	9,400	34
Industry	20,000	42	6,400	32	13,600	48
Government	6,800	14	1,800	9	5,000	18
TOTAL	48,000		20,000		28,000	

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[a] The 1970 total of 48,000 is apportioned by occupational sector according to the distribution of the 1968 total of 46,000 (BLS data).

[b] The distribution of the 20,000 estimated PhD's is based on the 16,600 PhD respondents to the 1970 National Register.

[c] Difference between BLS numbers and numbers of Register PhD's.

The distribution of non-PhD professional physicists in the 1970 National Register by BLS occupational sectors is shown in greater detail in Table II.38. Clearly, the Register population in a given year represents about half of the universe of non-PhD physics employment, and the representation by sector is entirely consistent with that universe. The professional non-PhD population represented by the 19,700 Register respondents in 1970 is difficult to estimate because of migration to and from this group. Some indication of its size can be made by means of a calculation that yields a correct answer when applied to PhD Register respondents. There were 3677 qualified respondents in 1968, having a median age of 34.5 years, who did not respond again in 1970. If we assume an equal number were not heard from in either 1968 or 1970, the nonrespondent component of the Register-qualified population is about 7400, of whom a few would be students, about 600 would be high school teachers, and the remaining 6800 would be in the work force. The total number of Register qualified non-PhD's in the work force is, thus, about 20,200, or 72.5 percent of the BLS total. We estimate, then, that professionally qualified——on the basis of education, experience, and professional self-identification——non-PhD physicists amount to about 72 percent of the BLS-employer estimated non-PhD physics work force. Responses to the combined 1968 and 1970 Register surveys amount to 83 percent of the qualified work force; 1970 respondents alone amount to 67 percent of those who are qualified. In addition, the respondents include representative populations of high school teachers as well as advanced graduate students and others who will be entering the work force.

The distribution of non-PhD physicists according to the type of employing institution used in previous tables based on Register data is shown in Table II.39, with PhD's included for comparison. Not surprisingly, non-PhD's are much less likely to hold faculty positions in universities than are PhD's; however, junior college

TABLE II.38 Labor Force Distribution of Non-PhD Respondents to the 1970 National Register by BLS Occupational Categories

BLS Occupational Sector	Non-PhD's Number		Percent
University and College	4,600		34
University:			
Faculty		2,000	
FTE student employees[a]		1,300	
Junior college		800	
University operated federal research centers		500	
Industry	6,300		47
Industry		5,350	
Industrially operated federal research centers		400	
Other		550	
Government	2,500		
Subtotal (BLS occupations)	13,400		
Other Occupations	6,300		
Students (not included above)		2,100	
High school teachers		1,600	
Military		600	
Unknown employer		2,000	
Total, 1970 National Register	19,700		

[a] The full-time equivalence (FTE) of 2600 university teaching and research assistants on the 1970 Register is estimated at 50 percent on the basis of NSF data. The NSF (Report NSF 70-16) gives the FTE of 84,391 graduate students in part-time employment as 40,443.

teaching is done largely by non-PhD's. An extensive study of junior college teachers in 1967 (NSF 69-3) shows that about half of those teaching physics did so full time. There were 496 full-time physics junior college teachers then, and 5 percent of the physics courses were taught by PhD's. In the 1970 Register sample, there were 845 physicists in junior colleges, 7 percent of whom were PhD's. The growth implied is consistent with overall physical science faculty growth in these institutions, but the NSF and Register populations are not strictly comparable. It is evident, however, that the rapid growth of two-year colleges has not entailed an accelerated recruitment of PhD's during the 1967-1970 interval. To an even greater extent, the teaching of physics in high schools is done by non-PhD's.

Industry and the federal government provide employment for 55 percent of the non-PhD's compared with 38.5 percent for PhD's. Research centers employ only 6 percent of the non-PhD's compared with 14 percent of the PhD's. These differences are consistent with the relatively greater emphasis on applied research and development in the employment of non-PhD's.

TABLE II.39 Employing Institutions of Non-PhD's and PhD's, 1970

Employer	Non-PhD's		PhD's	
	Number	Percent	Number	Percent
University (faculty)	1,990	13.9	5,723	41.6
Industry	5,346	37.2	3,805	27.7
Government	2,545	17.8	1,468	10.8
Research center	877	6.1	1,912	13.9
Other	3,588	24.3	840	6.1
Secondary school	1,628	16.1	31	0.6
Junior college	791		54	
Military	650	8.2	113	5.5
Other	533		642	
SUBTOTAL[a]	14,346		13,748	
University (non-faculty)	3,319		2,500	
Unknown	2,026		383	
TOTAL	19,705		16,631	
Median age	32.9		37.4	

[a] The non-PhD sample represents an estimated 67 percent of the universe of Register qualified full-time professionals; the PhD sample is approximately 85 percent of the PhD universe.

II.1.3.3.2 *Educational Mobility of Non-PhD Physicists* Some 60 percent of the non-PhD physicists hold a master's degree. Between 1968 and 1970, departmental surveys indicated that there were about 8000 graduate students in the third year of training or beyond. This pool of qualified non-PhD physicists is one fifth the size of the nonstudent professional work force, estimated at 20,000 non-PhD's and 20,000 PhD's. Most of these students are employed, 60 percent of them part time and 19 percent full time, usually in universities. Graduate students thus represent the supply of potential professional physicists and their employment demonstrates a demand for non-PhD physicists, especially in universities.

The mobility of physicists in regard to student status between 1968 and 1970 is shown in Table II.40. By 1970, 77 percent of the

TABLE II.40 Educational Mobility of Qualified Non-PhD Physicists between 1968 and 1970

Status in 1968	Status in 1970 Student Full Time	Student Part Time	Nonstudent Non-PhD	Nonstudent New PhD	1968 Total
Student					
Full time	899	73	1,055	1,624	3,651
Part time	81	226	1,277	226	1,807
Subtotal		1,279 (23%)	2,332 (43%)	1,847 (34%)	5,485[a]
Nonstudent					
Non-PhD	149	169	8,738	-	9,056
Subtotal		318 (4%)	8,738 (96%)		9,056
1970 total	1,129	486	11,070	1,847	14,514
Median age	28.3	31.6	36.8	29.9	

[a] In 1968 there were 7800 graduate students beyond the second year of training.

[b] The Doctorate Records File counts 2874 new PhD's in academic years 1967-1968 and 1968-1969.

1968 advanced graduate students had entered the nonstudent work force, 34 percent as new PhD's and 43 percent generally as terminal non-PhD professionals; 23 percent continued their training. Return to graduate study was reported by 4 percent of the regularly employed non-PhD population.

II.1.3.3.3 *Subfield Distribution of Non-PhD's* The subfield of employment of nonstudent non-PhD's and advanced graduate students appears in Table II.41. To a large extent the subfield distribution of non-PhD employment is negatively correlated with the employment of young PhD's shown in Table II.26 and Figure II.4. However, a positive correlation exists between the subfield employment of non-PhD's and mature PhD's. The subfield interest profile of graduate students corresponds to that of PhD university faculty, shown in Table II.24, and is negatively correlated with non-PhD employment. The most striking mismatches between graduate training and non-PhD employment occur in optics, acoustics, and earth and planetary physics. These three subfields, which employ a greater than average number of non-PhD's, are those least represented in the ratio of student emphasis to non-PhD employment. Whether graduate education is an adequate source of non-PhD physicists, the profile of specialized training in graduate schools does not correspond to the profile of specialties characteristic of the employment of non-PhD's.

TABLE II.41 Subfield Distribution of Non-PhD Physicists—Students and Nonstudents—1970

Physics Subfield	Students	Nonstudents
Astrophysics and relativity	80	79
Elementary-particle	437	413
Nuclear	443	1,168
Atomic, molecular, and electron	286	576
Plasmas and fluids	195	503
Condensed-matter	1,005	2,573
Earth and planetary	157	567
Physics in biology	53	135
Optics	233	1,936
Acoustics	67	704
Astronomy	145	344
Miscellaneous[a]	857	6,749
TOTAL	3,958	15,747

[a] Other physics, 27 percent; teaching, 46 percent; other sciences, 27 percent.

As is true of PhD's, subfield mobility among non-PhD's provides the means of adjusting manpower supply to the prevailing patterns of use. Of 5759 non-PhD's in eight major subfields in 1968 and 1970, 73 percent remained in the same subfield throughout the two-year interval, a percentage equivalent to that for PhD's.

A measure of subfield mobility among relatively established non-PhD's can be derived by using the population who did not change types of employing institution between 1968 and 1970; for this group the mobility among major subfields was 23 percent, compared with 20 percent for established PhD's. One difference between non-PhD's and PhD's is that the simultaneous subfield mobility of employer mobile individuals is considerable enhanced—38 percent of non-PhD's compared with 23 percent of PhD's changed type of employment, and 26 percent of non-PhD's compared with 20 percent of PhD's changed subfield also. Non-PhD's apparently are somewhat more likely to adjust subfield emphasis to suit new employment than are PhD's. An important similarity between non-PhD's and PhD's is that subfield mobility shows a negligible dependence on age. In a two-year period, changes in subfield among the eight major ones comprising physics by approximately one fourth of the physics population seems to be characteristic of professional physicists, regardless of age or degree status.

Since industry and government are the major employers of non-PhD's, we examined the subfield distribution of non-PhD's thus employed. As shown in Figure II.7, employment outside the discipline-specific subfields amounts to approximately 30 percent for those in both types of employing institutions. This miscellaneous category,

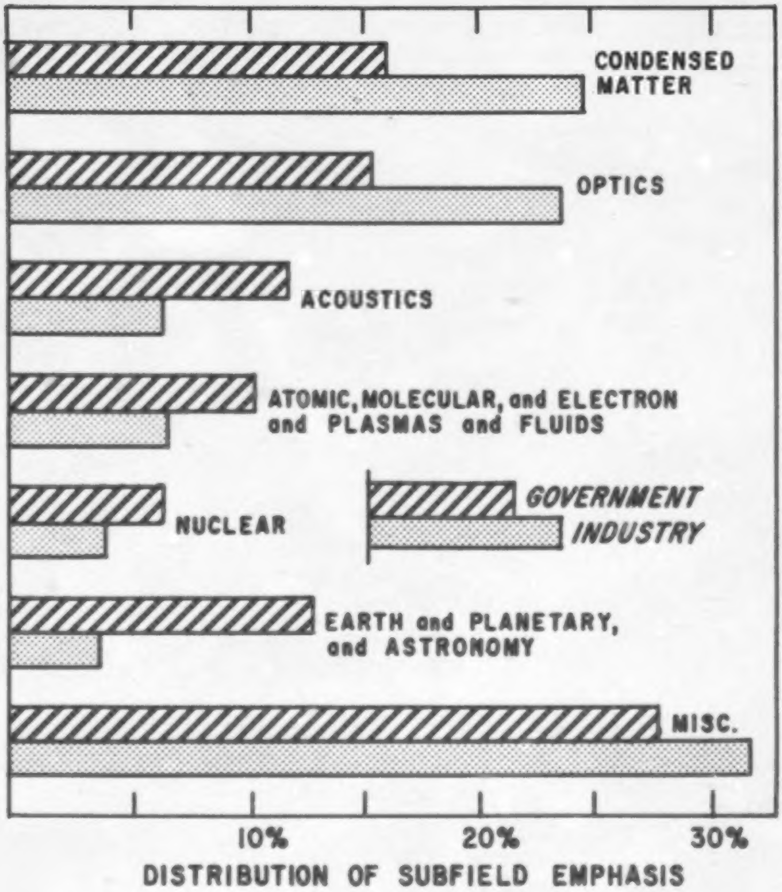

FIGURE II.7 Subfields of non-PhD physicists in industrial and government employment.

for both industry and government, can be subdivided into general physics (48 percent), computer science and mathematics (30 percent), and other sciences (22 percent). Optics and condensed matter together provide about 50 percent and 30 percent of the non-PhD employment in industry and government, respectively. The percentages for PhD's thus employed were 60 percent and 30 percent. Other than condensed matter and optics, industrial and government employment entails about the same mix of acoustics; atomic, molecular, and electron physics; plasma physics and physics of fluids; and nuclear physics, although the proportion engaged in these subfields is slightly greater among government-employed non-PhD's. Earth and planetary physics, particularly atmospheric physics, and astronomy are the subfields of a greater number of non-PhD's in government than in industry.

II.1.3.3.4 *Work Activities of Non-PhD Physicists* Like their PhD counterparts, the major work activities of non-PhD professional physicists are research and development. The difference is that for PhD's research is the primary activity; for non-PhD's development is primary. Figure II.8 compares work activities of PhD's and non-PhD's in industry. The same differences prevail in all types of employing institutions, as Table II.42 shows. Clearly, the development work done by professional physicists is performed largely by non-PhD's. In regard to primary work activity alone, about 7 percent of the total professional work force is engaged in development and 85 percent of these are non-PhD's. Because development is a major activity of private industry, which is the principal employer of non-PhD physicists, we examined the development activities of physicists in industry in greater detail in Table II.43. Development-related work activity constitutes 37 percent of industrial employment. For about half of those involved in development, it is a secondary activity, particularly for PhD's, and it is more likely to be secondary to basic and applied research for PhD's than for non-PhD's. If full-time involvement in primary and secondary development activity is assumed to be equal, 78 percent of the industrially employed physicists in development are non-PhD's.

Consistent with their major role in development, non-PhD's represent a correspondingly large fraction of the physics population in industry that is engaged in activities other than research and development. About 9 percent of the physicists in industry are employed in activities other than research and development; of these 84 percent are non-PhD's (see Table II.44). Just as development was frequently combined with research, other activities are combined with research and development by another 24 percent of the physicists in industry, 72 percent of whom are non-PhD's. It is clear from Table II.44 that management responsibilities are highly correlated with non-research-and-development employment of physicists.

The use of qualified non-PhD physicists by industry has a certain relevance to projected industrial PhD use. To the extent that research and development level or decline is a fraction of the gross national product, increased employment of PhD physicists in other activities than these by industry is inevitable. The aggregate experience of professionaly qualified non-PhD physicists provides a model for the kinds of changes that are likely to take place in PhD use patterns. The adjustments appear to be essentially continuous, starting with increased involvement in non-research-and-development activities in conjunction with research and development, and, if the changes follow pre-existent motivational patterns, one can expect an increased emphasis on the management role of phyicists, alrsady a substantial feature of professional employment.

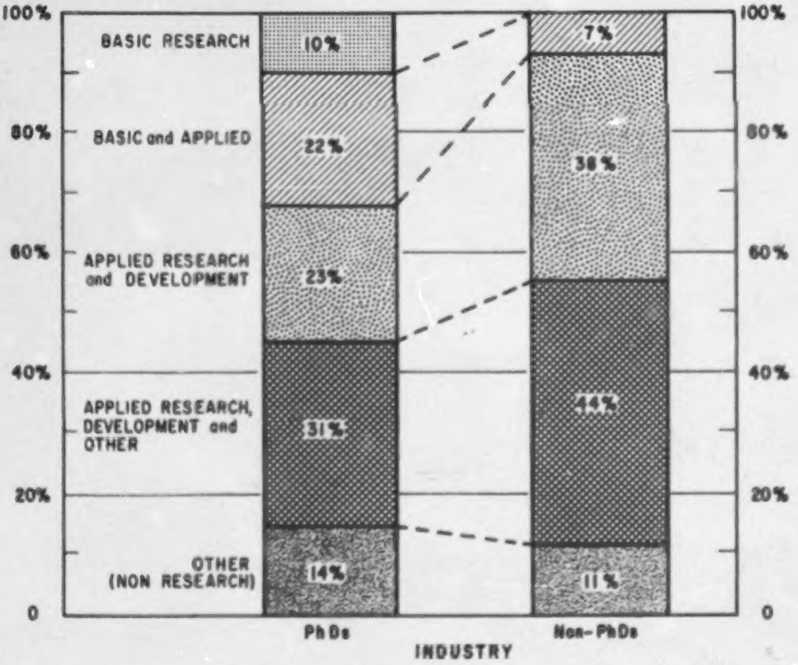

FIGURE II.8 The comparison of work activity priorities of non-PhD and PhD physicists in industry. (See caption to Figure II.1 for exact definitions of groupings.)

The NSF predicts a substantial demand in the next decade for non-academic, non-research-and-development PhD physicists, a demand that is not reflected in current functional distributions or in the trends in these distributions. The NSF estimates that 42 percent of the nonacademic employment of new PhD's will be in activities other than research and development. If this projection is based on a demand rather than an absorption process, increasing numbers of PhD's could be expected to assume a status-consistent modification of the traditional roles of non-PhD physicists. Thus non-PhD professionals could be providing a certain *de facto* leadership for the physics community and, possibly, leadership away from traditional physics.

TABLE II.42 Comparison of Primary Work Activities on Non-PhD and PhD Physicists by Type of Employing Institution

Primary Work Activity	University (Age 40-60)		Industry		Government		Research Center	
	Non-PhD	PhD	Non-PhD	PhD	Non-PhD	PhD	Non-PhD	PhD
Basic research	8.2%	24.2%	3.6%	19.3%	16.4%	48.4%	26.9%	44.3%
Applied research	7.5	3.4	33.4	39.0	37.9	18.9	30.7	28.2
Development	1.2	0.1	22.4	6.7	8.4	0.9	12.6	3.5
Management of research and development	4.7	5.4	16.4	24.0	19.2	23.4	13.0	18.4
Other	78.4	66.9	23.0	8.9	18.1	8.5	15.2	4.7

TABLE II.43 Performance of Development in U.S. Industry by Professional Physicists, Universe Total,[a] 1970

Priority of Development	Non-PhD		PhD		Total
Primary activity	1780		310		2,090
Secondary activity	1800		740		2,540
Basic and applied research primary		47%		72%	
Other activity primary		53		28	
Total in development	3580	78	1050	22	4,630 (37%)
Industry total	7980	63	4620	37	12,600

[a] Universe totals are estimated from Register respondents, assuming an 83 percent response from PhD's and a 67 percent response from non-PhD professionals.

TABLE II.44 Comparison of Research and Development, Non-Research and Development, and Management Responsibilities of Non-PhD's and PhD's in Industry, 1970

Responsibilities	Non-PhD (N = 5273)[a]		PhD (N = 3733)[b]	
Research and development	61%		77%	
Research and development		71%		62%
Research and development plus management		29		38
Research and development combined with non-research and development	27		19	
Combined		57		54
Combined plus management		43		46
Non-research and development	12		4	
Non-research and development		51		45
Non-research and development plus management		49		55

[a] Estimated universe = 7980.

[b] Estimated universe = 4620.

II.1.4 SPECIAL IN-DEPTH STUDIES

In the foregoing discussion of physics manpower employment, and mobility, attention has been directed primarily to physics as a whole, although with some indication of variation by subfield. It is also possible to use the Register data to provide in-depth studies of different subfields. Two interdisciplinary subfields have been selected as examples—astrophysics and relativity and earth and planetary physics.

II.1.4.1 *Manpower in Astrophysics and Relativity*

The distinction between astronomer and physicist is especially difficult to draw in astrophysics and relativity. However, we can identify these scientists by the detailed specialties in which they are engaged. The specialties that comprise astrophysics and relativity appeared in Table VIII.1 of Volume II, Part B, of *Physics in Perspective*, reproduced here as Table II.45.

TABLE II.45 Core Manpower in Astrophysics and Relativity, 1970[a]

Specialty	PhD's	Non-PhD's
Gravitational fields, gravitons	26	8
Cosmology	16	8
Galaxies	45	17
Quasars, pulsars, and x-ray sources	84	40
Relativity, gravitation	77	35
	248	108
Other[b]	9	51
Total respondents	257(62%)	159(38%)
Student respondents		80

[a] Data in the table are based on the National Register of Scientific and Technical Personnel.

[b] Respondents definitely in astrophysics and relativity, but for whom some items of Register data are missing.

Some 250 PhD's indicated that their major scientific work was in one of these specialties. For comparison, the specialties that comprise our Register definition of astronomy appear in Appendix B; 635 PhD's were identified with these specialties.

Characteristics of scientists in astrophysics and relativity suggest multiple subfield relationships. Important in identifying manpower at the interface of physics and astronomy is earth and planetary physics, with 725 PhD's, the specialties of whom also appear in Appendix B.

To count astronomers and physicists in this interrelated community is an oversimplification; however, to compare these data with those resulting from the questionnaire circulated to institutions by the Astronomy Survey Committee, we shall undertake such a count. Many PhD's working at this interface would, of course, be counted by astronomers as astronomers and by physicists as physicists. The use of Register specialties to define the population obviates such double counting.

The Register also obtains the self-identification of respondents. The results of this self-identification appear in Table II.46. The astronomers identified by institutions should include both self-identified astronomers and astrophysicists, a total of 867 respondents, whom we estimate to be 85 percent of a total population of some 1030 self-identified PhD astronomers.

TABLE II.46 PhD Self-Identification

Register Subfield	PhD Self-Identification				Subfield Total
	Astronomy	Astrophysics	Space Physics	Other Physics	
Astrophysics and relativity	55	72	9	121	257
Earth and planetary	15	61	189	458	724
Astronomy	286	209	50	99	644
Other physics	92	86	119	14,709	15,006
TOTAL	448	428	367	15,387	16,631

An institutional definition of an astronomer, however, is one who is working on what, in the management's view, is astronomy. All those working in the Register specialties classified as astrophysics and relativity and astronomy would surely be included in such an enumeration, and some fraction of the earth and planetary physicists would be counted as well. The latter fraction could be estimated by establishing the way in which management would classify each of the relevant specialties in Appendix B. As Table II.46 shows, about 20 percent of the earth and planetary physicists identify themselves as astronomers or astrophysicists; that is to say, about 150 of the 725 PhD's in earth and planetary physics could be identified with the institutions of astronomy.

Table II.47 summarizes the results and shows 1050 PhD respondents whom we believe could be readily identified as astronomers from the viewpoint of managers of institutions working in physics and astronomy. If we assume an 85 percent rate of response, then the population of permanent U.S. resident PhD astronomers in such institutions would amount to 1240 as of January 1970. This figure can be compared with the 1257 full-time, PhD-equivalent astronomy personnel, including teachers, postdoctoral fellows, locally paid staff visiting elsewhere, and visitors paid locally, who were reported by managers to be employed in 171 astronomy institutions in the United States and Galapagos Islands, which were surveyed by the Astronomy Survey Committee.

TABLE II.47 Identification of PhD Physicists and Astronomers with the Institutions of Physics and Astronomy

	PhD's in Register Subfields				Institutional
Institution	Physics	Earth & Planetary	Astrophys. & Relativ.	Astron.	Totals
Physics related	15,000	575			15,975
Both physics and astronomy related		150	250		1,050
Astronomy related				650	

FIGURE II.9 depicts the interrelationship of physics and astronomy in these two subfields—astrophysics and relativity and earth and planetary physics.

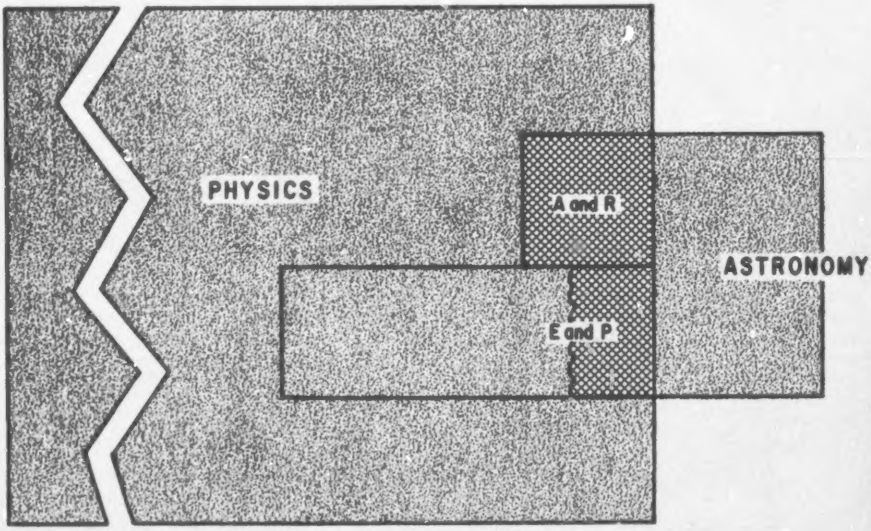

FIGURE II.9 The interpenetration of physics and astronomy.

The characteristics of manpower in astrophysics and relativity are depicted in Tables II.48–II.54. Employment is concentrated in universities and the university-based PhD's are principally engaged in research. The distribution by academic rank is characteristic of a research-oriented group with a large number of young university-based researchers. Emphasis on theory is greater than in either physics or astronomy. Consistent with this emphasis, the production of journal articles is high; in 1968 the subfield accounted for 0.9 percent of the physics community but produced 1.6 percent of the articles in a sample from *Physics Abstracts* (see Chapter IV).

TABLE II.48 Distribution by Employing Institution of Physicists, Astronomers, and Those in Astrophysics and Relativity

Subfield of Discipline	University	Industry	Government	Research Center	Other
Astrophysics and relativity	73%	7%	9%	9%	4%
Astronomy	63%	7%	18%	11%	5%
Physics	50%	24%	9%	12%	5%

TABLE II.49 Distribution of Work Activities of University-Based Group

Primary Work Activity	Astrophysics & Relativity	Astronomy	Physics
Basic research	66.3%	60.4%	37.2%
Teaching	29.3%	28.8%	49.7%
Other	4.4%	10.8%	13.1%

TABLE II.50 Distribution by Academic Rank

Rank	Astrophys. & Relativ.		Astronomy		Physics	
	Number	Percent	Number	Percent	Number	Percent
Full professor	43	24	102	28	2421	29
Associate	31	17	49	13	1697	21
Assistant	46	25	104	28	2101	26
Faculty total	120	66	255	69	6219	76
Other univ. employment	61	34	116	31	1989	24
Total PhD's	181		371		8208	

TABLE II.51 Distribution of Theoreticians and Experimentalists

Nature of Work	Astrophysics and Relativity(%)	Astronomy(%)	Physics(%)
Theoretical	51	28	25
Experimental	30	40	50
Both	19	32	25

TABLE II.52 Distribution by Degree Level

Subfield or Discipline	PhD's	Nonstudent Non-PhD's	Non-PhD's per PhD
Astrophysics & relativity	250	79	0.3
Astronomy	650	344	0.5
Physics	15,600	15,700	1.0

TABLE II.53 Median Age of PhD's in 1970

Sample	Astrophys. & Relativ.	Astronomy	Physics
Theoreticians	33.9	33.8	35.0
Total	34.6	35.0	37.4

TABLE II.54 Median Age of PhD's in 1970 by Academic Rank

Rank	Astrophysics & Relativity	Physics/Astronomy
Full professor	46.0	46.8
Associate	36.7	37.4
Assistant	31.9	32.4

The subfield is composed of a comparatively young group, with a median age of 34.6. It affords relatively little opportunity for qualified non-PhD's.

The data show that scientists in astrophysics and relativity are somewhat more like astronomers than physicists, a result that could largely be expected from the institutional characteristics of a nonapplied discipline. To describe the interrelationship of physics, astrophysics and relativity, and astronomy, apart from the overriding institutional correlates, we can look at data on field of PhD, subfields of additional scientific competence, and subfield migration, Tables II.55—II.58. Astrophysics and relativity is populated largely by physics PhD's. The data on specialties of first and second competence other than specialty of employment show that for those in astrophysics and relativity specialties of first competence usually fall also within this subfield (82 percent so indicating). Astrophysics and relativity clearly is not a secondary pursuit; the secondary competences, physics and astronomy, are the intellectual and practical foundation for the creative thrust of this subfield.

TABLE II.55 Field in Which PhD Was Obtained

Field of PhD	Field of Current Research		
	Astronomy as a Whole(%)	Physics as a Whole(%)	Astrophysics and Relativity(%)
Physics	36	80	70
Astronomy	57	5	25
Other	7	15	5

TABLE II.56 Additional Subfield Competence of PhD's in Astrophysics and Relativity, Astronomy, and Physics

Subfield of Additional Competence	Subfield of Employment				
	Astrophys. & Relativity		Astronomy		Physics
	Number	Percent	Number	Percent	Number
First level					
Astrophys. & relativity	200	82	15	2	44
Astronomy	15	6	458	75	124
Physics	28	12	141	23	
Total first	243		614		15,000
Second level					
Astrophys. & relativity	85	35	57	10	82
Astronomy	42	17	279	46	158
Physics	117	48	261	44	
Total second	244		597		15,000

TABLE II.57 Numbers of PhD's in Astrophysics and Relativity, Astronomy, and Earth and Planetary Physics, 1964–1970

Year	Astrophys. and Relativity	Astronomy	Earth Planetary	Total Physics/Astronomy
1964	65	397	311	10,400
1966	-	-	-	11,800
1968	125	711	572	14,300
1970	250	644	724	16,600

TABLE II.58 Mobility into Astrophysics and Relativity and Earth and Planetary Physics

	1970 PhD's	
1968 Sources	Astrophys. and Relativity	Earth and Planetary
Same subfield	82	323
Physics	37	203
Astronomy	75	55
Longitudinal sample	195	581
1970 Register total	250	725

Growth in this subfield displays the explosive character typical of an exciting new research area of physics. Growth in both astrophysics and relativity and earth and planetary physics shows that substantial manpower is shifting into these subfields from traditional astronomy subfields. The patterns of growth also illustrate the close interrelationship of these subfields to physics and astronomy.

Figure II.10 depicts the components of growth in astrophysics and relativity. The largest input, 75 PhD's with a median age of 33.7 years in 1970, came from astronomy; only seven PhD's went from astrophysics and relativity to astronomy. Of those who entered from astronomy, 25 percent were under 31 years of age, and 25 per-

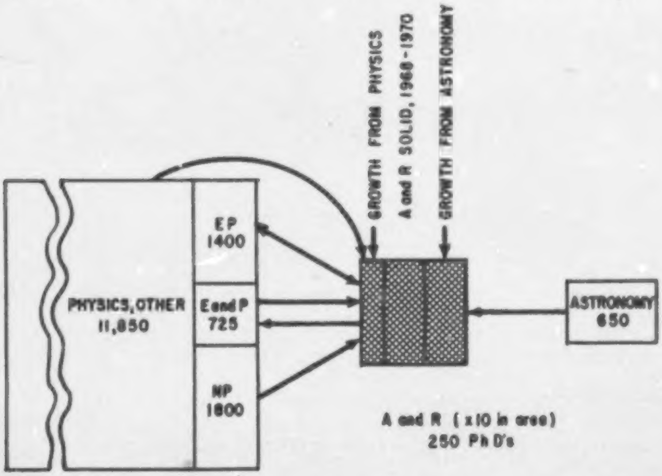
GROWTH FROM PHYSICS
A and R SOLID, 1968-1970
GROWTH FROM ASTRONOMY
EP
1400
PHYSICS, OTHER
11,850
E and P
725
NP
1800
ASTRONOMY
650
A and R (x10 in area)
250 PhD's

FIGURE II.10 Growth and interchange, 1968—1970. Numbers are 1970 Register populations.

cent, over 38 years of age; therefore, this subfield can hardly be said to attract only young astronomers. The interchange with physics was more nearly reciprocal. Thirty-seven came into the subfield from physics in 1970, and 21 left it to move into physics. Six came from nuclear physics, 11 from elementary-particle physics, 6 from earth and planetary physics, and 14 from other subfields. Of those who left, one went into nuclear physics, 9 into elementary-particle physics, 8 into earth and planetary physics, and 3 to other subfields.

II.1.4.2 *Manpower in Earth and Planetary Physics*

The study of the physical environment, the earth and its surroundings, clearly is a multidisciplinary activity that includes not just physicists but atmospheric, geological, and oceanographic scientists. About as many scientists are identified with earth and space science fields as with physics, perhaps 40,000 in each. An identifiable group of about 2000 physicists, those in earth and planetary physics, are working in earth and space sciences. If we look only at research effort, it appears that the earth and planetary physicists account for as much as 20 percent of the effort in earth and space studies.

The characteristics of earth and space scientists are drawn largely from National Register data; however, other data are available from BLS, NASA, and the Civil Service. We have used the Register data in our analyses, first, to depict the overall dimensions and characteristics of atmospheric, geological, and oceanographic populations and research effort and, second, to describe in detail the special characteristics of the earth and planetary physics population. Supplementary data, based largely on employer surveys, lack definitional consistency and are piecemeal, but they augment the manpower from the Register, giving in some cases quite different totals.

There are some 33,000 earth and space scientists and some 40,000 physicists. More than 1600 physicists work in earth and space sciences, but only a few earth and space scientists work in physics.*

Table II.59 shows the number of scientists working in earth and space sciences and physics. A scientist is classified as working in a field on the basis of his statement of a detailed specialty that most nearly corresponds to his principal work activity. The assignment of specialties provides a working definition of discipline and subfield.

Deciding what kind of scientist a respondent is is by no means as simple as deciding what science one is working in. If a Register form is returned to the AIP but the respondent seems more like a geoscientist than a physicist, his form is sent to the American Geological Institute (AGI) for review and inclusion

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*These figures are based on an estimated 85 percent response to the Register, which is conservative for PhD's and somewhat arbitrary for non-PhD's. For non-PhD's, definitions of professional standards, job classifications, and fields become rather fuzzy.

TABLE II.59 Manpower in Earth and Space Sciences[a]

Field of Employment	No. of Scientists	Principal Processing Society[b]	No. Identified with AIP	No. Holding PhD	Percentage of total Represented by AIP Scientists(%)	Percentage of Total with PhD(%)
Atmospheric sciences	5,232	AMS	453	639	8.7	12.2
Structure and dynamics	1,127		378	435	33.6	38.6
Other	4,105		75	204	1.8	5.0
Geological sciences	17,198	AGI	197	3,040	1.1	17.7
Geophysics	2,873		171	431	6.0	15.0
Other	14,325		26	2,609		18.2
Oceanography	730	AGI	53	203	7.3	27.8
Total atmospheric, geological, and oceanographic sciences	23,160		703	3,882	2.7	15.7
Space science	816	AIP	626	399	76.7	49.0
Physics specialties	25,801	AIP		11,405	100	44.2
Astronomy	1,325	AIP		733	100	55.3
Electronics	1,504	AIP		485	100	32.2
Identification						
Physics	32,491	AIP		14,311		44.0
Earth and marine sciences	23,746	AGI		4,957		21.0
Atmospheric and space sciences	5,745	AMS		514		9.0

[a] Data are based on *American Science Manpower 1968* (NSF 69-38) (Table A-48) and on the 1968 National Register of Scientific and Technical Personnel.

[b] Society responsible for the collection and processing of data in a particular discipline. These societies are the American Institute of Physics, American Geological Institute, and American Meteorological Society.

with their respondents if qualified. In Table II.59, the second column gives the processing society of most respondents in each category, thus the major professional identification of people working in earth and space sciences.

The data in Table II.59 are also depicted in Figure II.11, in a so-called "Fuji" representation.

In our earlier discussions of other populations, the overall size has been estimated on the basis of all scientists regardless of their specific work activity. However, in this section we shall look principally at the research function to get a clearer indication of the relative role of the physicist compared with earth and space scientists in the performance of research.

Before we examine the Register population in detail, we will look briefly at a special group. Scientists working in "physics of the earth in space" were convened by the National Academy of Sciences for study programs in the summers of 1968 and 1969. Fifty-two scientists participated, with continuity provided by 12 who participated in both summer sessions. We assumed that this group constituted an elite representation of scientific personnel in earth and space sciences. Table II.60 presents a tabulation of their scientific backgrounds and professional identifications.

TABLE II.60 Field and Degree Background of a Select Group of Earth and Space Scientists

	Field of Science with which Identified		Field of Degree	
Fields	Number	Percent	Number	Percent
Physics	17	38	21	58
Space physics	5	11	-	
Astrophysics/astronomy	8	18	4	11
Geophysics	7	16	4	11
Radio physics	4		2	
Electrical engineering	3		4	11
Aeronomy	1		-	
Physical chemistry	1		1	
TOTAL	46		36	

Data on 41 of the 52 were found in *American Men of Science* (11th edition). We looked particularly at major fields of professional identification (such as physicist or geophysicist), field of PhD, and society membership. The results suggest predominance of physics, with expertise in astronomy also a major constituent.

Society membership sometimes is regarded as a useful indication of subject emphasis; for this group it should be reasonably indicative because these are mature scientists whose economic status probably would override financial barriers to multiple

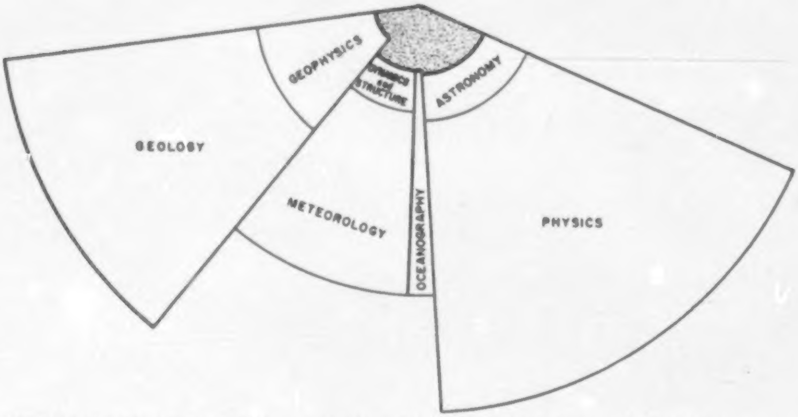

FIGURE II.11 Scientific manpower in earth and space sciences, physics, and earth and planetary physics.

memberships. Further, being acknowledged as successful in research, they would not be expected to join a society for reasons of status. Table II.61 presents data on society membership of this group. The distribution implies a sustained involvement with the physics community. Because of the small percentage reporting degree background in geosciences, membership in the American Geophysical Union, indicated by 56 percent, apparently reflects acquired identification with this community. A clear trend toward a connection with astronomy also is indicated, although it is difficult to say whether this association is traditional or acquired, for astronomy typically has relied on a substantial influx of PhD's from physics.

These simple data on the elite group suggest that research at the so-called frontiers of the earth and space sciences is done by people with a strong background in physics, who generally maintain connections with the physics and astronomy communities and have acquired a relationship to the geophysics community. Indeed, professional mobility is a prominent characteristic of the group.

We must examine properties other than size of various populations to get a quantitative idea of the relative role of physicists in earth and space sciences. The PhD concentration of a subfield or discipline is significant, because we find that publication patterns are strongly correlated with PhD distributions. The degree concentration, distributed according to professional identification appears in Table II.59, as well as concentration among work areas. Physicists clearly are concentrated in areas characterized by a high concentration of PhD's. Apparently physicists tend to be more strongly involved in advanced subject areas in which PhD training is important rather than in operations in which the generalist training of a physicist is usually considered a special cachet.

TABLE II.61 Society Membership of a Select Group of Earth and Space Scientists

Society	Membership Indicated Number	Membership Indicated Percent	Membership Distribution(%)
American Physical Society	15	37	21
American Geophysical Union	23	56	32
American Astronomical Society	15	37	21
Institute of Electrical and Electronics Engineers	12	29	17
American Meteorological Society	5		
American Chemical Society	1		
Total memberships	71		
Total on which this information was obtained	41		

Other comparisons to show the place of physicists in this interdisciplinary iceberg require the comparison of earth and planetary physicists and earth and space scientists. Nonoverlapping groups can be defined with reference to Table II.59. Earth and planetary physicists represent the physics (AIP) population. Earth and space scientists represent the earth and marine sciences (AGI) and atmospheric and space (American Meteorological Society) populations. We shall compare 26,000 earth and space scientists in 1968 (most recent *American Science Manpower* data) with 700 earth and planetary physicists in 1970, for we want to present the most recent picture of physicists against the more slowly changing background of earth and space sciences. When possible, PhD's and non-PhD's will be compared separately. Special characteristics of earth and planetary physicists will be discussed in detail in a later part of this section.

The distribution of earth and planetary physicists, compared with all physicists, among employing institutions appears in Table II.62. Clearly, research centers employ many of these earth and planetary physicists. Although *American Science Manpower* does not show research center as a separate category, comparison without data can be achieved by allocating research center PhD employees to universities (69 percent), industry (22 percent), and other employing institutions (9 percent). Table II.63 presents this comparison and shows that the nonuniversity employment pattern of earth and planetary physicists is more like that of earth and space scientists than of physicists. Nearly as many earth and planetary PhD's work for government as for industry, which resembles the employment pattern of earth and space scientists and differs from that of physicists among whom there is a three-to-one industry/government ratio of use.

TABLE II.62 Employment Patterns of Earth and Planetary Physics PhD's and Non-PhD's Compared with Those for the Total Physics Population[a]

Employing Institutions	Earth and Planetary PhD's N=712(%)	All Physics PhD's N=16,631(%)	Earth and Planetary Non-PhD's N=673(%)	All Physics Non-PhD's N=19,705(%)
College and university	38	51	33	28
Industry	23	23	20	33
Government	22	9	31	15
Research center	13	12	4	6
Other	4	5	12	18

[a] Data are from the 1970 NSF National Register of Scientific and Technical Personnel

TABLE II.63 Employment of PhD's in Earth and Space Sciences

	Employer							
	Academic		Industry		Government		Other	
Field	No.	%	No.	%	No.	%	No.	%
Earth and planetary physics	338[a]	47.5[a]	184[a]	26.0[a]	154[a]	21.6[a]	36[a]	5.0[a]
Earth and space sciences	3198	55.9	919	17.0	922	16.6	234	4.5
Earth and marine	2906	61.0	865	18.1	796	16.7	197	4.1
Atmospheric and space	292	57.5	44	8.7	126	24.8	47	9.3
Physics	-	59.0	-	26.0	-	9.0	-	5.0
Geology[b]	1229	46.4	572	18.4	448	21.7	148	7.6
Geophysics[b]	187	43.7	161	37.1	51	11.9	29	6.8
Oceanography[b]	123	62.5	16	8.1	45	23.0	13	6.6

[a] Estimated

[b] These groups are derived from numbers working in these fields (see Table II.59) and are commensurate with the other groups in this Table (II.63). The numbers are listed only for comparison of distributions.

Earth and planetary physicists are less often employed in universities than are physicists in general. In Table II.64, earth and planetary physics faculty is tabulated separately from university employees; comparisons are presented for physicists in general, nuclear physicists, astronomers, and AGI and American Meteorological Society populations. Faculty is defined as academic employees who specify academic rank of lecturer or above. Of 272 earth and planetary physicists in universities, 173 acknowledged

TABLE II.64 Faculty Members in Earth and Planetary Physics, Physics, and Earth and Space Sciences[a]

Field of Degree	Total Faculty	Professor or Dean	Associate Professor	Assistant Professor	Instructor or Lecturer
Physics	7427	2625	2047	2753	702
Earth and planetary physics					
PhD	173	66	46	55	6
Total	206	69	51	68	18
Nuclear physics	798	264	229	246	59
Astronomy	289				
Earth and space sciences	3868	1141	939	1213	575
Earth and marine	3580	1042	865	1135	538
Atmospheric and space	288	99	74	78	37
PhD	2632	1048	768	774	42

[a] Grouped according to research specialty rather than academic department. Data on physicists are based on the physics section of the 1970 National Register; those on earth and space sciences on *American Science Manpower* 1968.

faculty appointments; an additional 36 of [illegible] non-PhD's also claim such appointments. Table II.65 summarizes data on faculty roles of PhD's employed in universities presented in Tables II.63 and II.64. Clearly, earth and planetary physicists are not heavily engaged in teaching; they are not only less likely than either physicists or earth and space scientists to be employed in universities, but those who are thus employed are less likely to fill faculty positions. If earth and planetary physics is to assume a more prominent place in the physics curriculum, substantial mobility will be required. There are about 175 self-acknowledged earth and planetary physics PhD faculty members, not all of whom are in the 2000 U.S. physics departments. Increased emphasis on faculty responsibilities could lead to an influx of earth and planetary physicists from the immediate academic surroundings, a pool that amounts to some 150 additional PhD's. A second source is academic physicists who are competent in earth and planetary

TABLE II.65 Comparison of Roles in Academic Institutions[a] of PhD's in Earth and Planetary Physics, Physics, and Earth and Space Sciences

Field	Faculty		Other	
	Number	Percent	Number	Percent
Earth and planetary physics (1970) $N = 338$	173	51	165	49
Physics (1970) $N = 9700$	6430	62	3270	38
Earth and space sciences (1968) $N = 3198$	2632	82	566	18

[a] Includes research centers operated by universities.

physics but who are not currently working in this subfield. Their number amounts to another 50 to 60 PhD's currently in college or university employment. Taken together these two sources do not represent a large pool, compared with, for example, nuclear physics. It is clear that expansion of earth and planetary physics in the physics curriculum would be manpower limited. A third kind of mobility, intellectual mobility of subfield switching, would be needed. A favorable outcome is possible from this third source, for intellectual mobility is a major characteristic of the physics population.

Table II.66 shows the production of students in 1968 in the fields with which we are concerned. Although the total production is about the same for physicists and earth and space scientists, the concentration of PhD's is twice as high in physics. As Table II.67 shows, patterns of degree production differ from those of use. Only a fraction of non-PhD's enter scientific work in any case, but the pattern is quite different for physicists and earth and space scientists.

Table II.68 summarizes the primary work activities of earth and space scientists and earth and planetary physicists. The differences in work patterns are striking. A high proportion of PhD's and non-PhD's in earth and planetary physics are engaged in research (67 percent and 64 percent, respectively). The comparable figures for research for all physics are 55 percent for PhD's and 47 percent for non-PhD's. In the earth and space sciences, the

TABLE II.66 Degree Production, 1968[a]

Field	BS	MS	PhD	PhD as Percentage of Total(%)	Degrees/Faculty
Physics	5500	2000	1400	16	1.3
Earth and space sciences	2900	1100	438	8	1.2
Earth sciences			341		
Oceanography			49		
Meteorology			48		

[a] Sources of data presented in this table are the American Institute of Physics, American Geological Institute, and NRC Doctorate Records File.

TABLE II.67 Production and Use of Physics PhD's in Physics and Earth and Space Sciences

Field	PhD Production(%)	PhD Use in Field(%)
Physics	16	44
Earth and space sciences	8	18.5

figures are 32 percent (PhD) and 18 percent (non-PhD). This finding reinforces the conclusion, derived from almost all types of data on these fields, that patterns of activity and employment in earth and planetary physics differ from those for both the earth and space sciences as a whole and physics. The especially high research commitment among non-PhD earth and planetary physicists suggest that they function much more in the way that PhD's do than is the case in other fields.

Table II.69 shows numbers and percentages of PhD's and non-PhD's engaged in research in various employment settings. The emphasis on research that characterizes the earth and planetary physicist clearly is not a function of type of employing institution, and the estimated allocation of 20 percent of the total research effort in earth and space sciences to earth and planetary physicists probably is conservative. Even non-PhD's in earth and planetary physics amount to 12 percent of the research-oriented non-PhD total.

TABLE II.68 Primary Work Activities of Earth and Space Scientists[a]

Degree and Field	Work Activities (%)			
	Research[b]	Teaching	R & D Management	Other[c]
PhD's				
Earth and planetary (*N* = 707)	67	13	15	5
AGI scientists (*N* = 4689)	30	42	9	19
AMS scientists (*N* = 493)	50	23	16	10
Non-PhD's				
Earth and planetary (*N* = 657)	64	7	11	18
AGI scientists (*N* = 21,746)	17	18	6	59
AMS scientists (*N* = 5413)	20	5	7	67

[a] Data for the American Geological Institute and the American Meteorological Society respondents are based on *American Science Manpower 1968*; those on earth and planetary physics are based on the 1970 National Register survey.

[b] Research includes basic and applied as well as the design and development category, which has a negligible effect in these groups.

[c] The "other" category includes exploration and forecasting, which are major activities of many scientists in the geological and meteorological groups.

In the academic community in which the teaching-research function is especially important, the commitment of earth and planetary physicists to research again is striking. Tables II.70a — II.70d compare primary and secondary work activity of university-based scientists. One fourth of the earth and planetary physicists indicated research as both first and second major activity. Another one fourth reported research as primary and teaching secondary, and 14.6 percent combined research with some other secondary activity, the other category including such activities as administration and management. In all, 64.6 percent indicated research as the primary work activity. Although 14.4 percent of the earth and planetary physicists are primarily engaged in work that is neither research nor teaching, approximately five in seven of them report a secondary commitment to research.

TABLE II.69 Distribution by Employer of Those Engaged in Research

Degree and Field	Total	Academic No.	Academic %	Industry No.	Industry %	Government No.	Government %	Other No.	Other %
PhD's	2135	859	40	440	20	699	33	137	6
Earth and planetary physics	474 (22%)	206	23	129	29	116	18	23	17
Earth and space sciences	1661 (78%)	653	76	311	71	583	82	114	83
AGI scientists	1415	513		292		517		93	
AMS scientists	246	140		19		66		21	
Non-PhD's	3550	1123		728		1422		284	
Earth and planetary physics	420 (12%)	173	15	82	11	138	10	27	10
Earth and space sciences	3137 (88%)	950	85	646	89	1284	90	257	90
AGI scientists	2310	683		541		970		116	
AMS scientists	827	267		105		315		141	

TABLE II.70a Primary and Secondary Work Activity of University-Employed Earth and Planetary Physicists[a]

Primary Work Activity	Secondary Work Activity(%) Research	Teaching	Other	Primary Totals(%)
Research and development	26.4	23.6	14.6	64.4
Teaching	16.6	3.3	1.1	21.0
Other	5.7	8.7		14.4

[a] All degrees included, *N* = 493 (1970 National Register).

The data in Table II.70 must be regarded as semiquantitative. Figures II.12 and II.13, which compare earth and planetary physicists with earth and space scientists, depict the differences in these data for the two groups.

We shall now examine the data on earth and planetary physicists in greater detail—self-identification, degree background, work activities and competence, and changes in these characteristics with time.

TABLE II.70b Primary and Secondary Work Activity of University-Employed Physicists[a]

Primary Work Activity	Secondary Work Activity(%) Research	Teaching	Other	Primary Totals(%)
Research and development[b]	16.9	23.7	6.5	47.1
Teaching	29.4	7.3	7.3	44.0
Other	2.1	2.9	3.8	8.8

[a] All degrees included, $N = 13{,}532$ (1970 National Register).
[b] Development and design = 0.6 percent of primary research and development activity.

TABLE II.70c Primary and Secondary Work Activity of University Employed American Geological Institute Scientists[a]

Primary Work Activity	Secondary Work Activity(%) Research	Teaching	Other	Primary Totals(%)
Research and development[b]	6.9	11.1	3.6	21.6
Teaching	39.0	12.6	13.4	65.0
Other	3.2	10.0		13.4

[a] All degrees included, $N = 5479$ (*American Science Manpower 1968*).
[b] Development is generally negligible.

TABLE II.70d Primary and Secondary Work Activity of University-Employed American Meteorological Society Scientists[a]

Primary Work Activity	Secondary Work Activity(%) Research	Teaching	Other	Primary Totals(%)
Research and development[b]	22.2	20.2	13.5	55.7
Teaching	18.7	2.1	6.6	27.4
Other	6.5	13.3		16.9

[a] All degrees included, $N = 782$ (*American Science Manpower 1968*).
[b] Development is generally negligible.

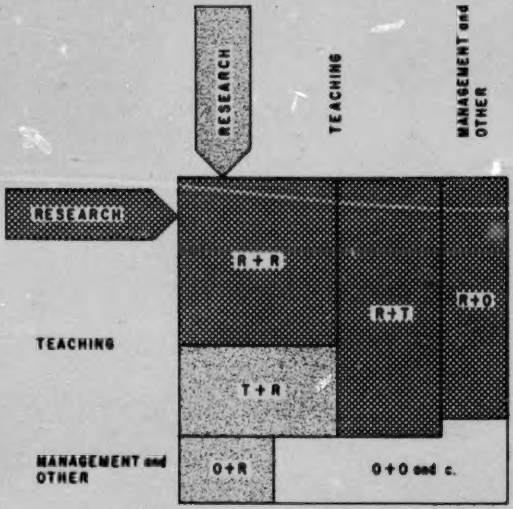
RESEARCH
TEACHING
MANAGEMENT and OTHER
RESEARCH
TEACHING
MANAGEMENT and OTHER
R+R
R+T
R+O
T+R
O+R
O+O and c.

FIGURE II.12 Work activities of university-employed earth and planetary physicists.

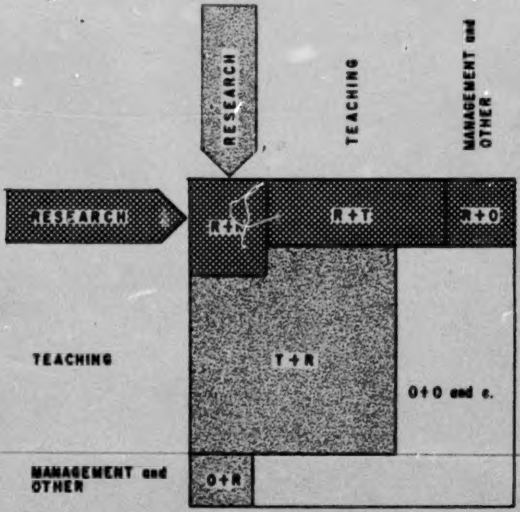
RESEARCH
TEACHING
MANAGEMENT and OTHER
RESEARCH
TEACHING
MANAGEMENT and OTHER
R+R
R+T
R+O
T+R
O+O and c.
O+R

FIGURE II.13 Work activities of university-employed geoscientists and meteorologists.

The composition of earth and planetary physics, based on self-identification of its manpower, appears in Table II.71. We emphasize that the group is constructed from people generally identifiable as physicists who are working in earth and planetary physics; the distribution of self-identification that is found by reading across the top row of Table II.71 is a description of these people rather than a means of identifying them. The nature of professional self-identification becomes clearer as one reads down the columns of the table, noting that, for example, 51.5 percent of the AIP space physicists are working in earth and planetary physics, 13.7 percent in astronomy, 8.4 percent in plasmas and fluids, and 26.4 percent in various other subfields. There are, of course, self-identified physicists in the AGI and American Meteorological Society portions of the Register who are not counted in the vertical totals of this table.

Table II.72 shows the degree background of earth and planetary physicists. Engineering and astronomy account for most of the nonphysics PhD's.

The detailed list of work specialties on the Register that we have defined as earth and planetary physics appears in Appendix B, with the numbers of PhD's and non-PhD's engaged in each. No one specialty is preeminent, so that in discussing this subfield the characteristics of earth and planetary physicists are not dominated by some highly specialized particular research-interest group.

TABLE II.71 Professional Self-Identification of Earth and Planetary Physics PhD's

	Self-Identification					
Subfield of Employment	Space Physicist	Atmospheric Physicist	Geophysicist	Astrophysicist	Physicist	Other
Earth and planetary	26.1%	16.4%	7.3%	8.4%	30.7%	11.1%
	51.5%	70.8%	55.2%	14.3%	2.0%	
Astronomy	13.7%	-	-	48.7%	0.5%	
Astrophysics	-	-	-	14.3%	1.0%	
Plasmas and fluids	8.4%	6.0%	10.4%	-	6.4%	
Other subfields	26.4%	23.2%	34.4%	20.2%	90.5%	
Total *N*'s	367	168	96	428	10,969	2824

TABLE II.72 Comparison of Field of PhD Degree by Panel (Employment Specialty), 1968 and 1970

Physics Subfield	Total N^a		% PhD's in Physics		PhD's in Other Fields (only for >5% of total)					
	1968	1970	1968	1970	1st Field	%1968	%1970	2nd Field	%1968	%1970
Total	14,087	16,248	79.9	78.8	Eng.	8.7	10.0	-		
Subtotal physics	13,389	15,614	82.2	80.5	Eng.	9.0	10.3	-		
Astrophysics and relativity	123	252	84.6	70.2	Astron.	15.4	25.0			
Atomic, molecular, and electron	998	1,065	81.3	77.8	Chem.	10.5	13.0	Eng.	6.1	6.5
Elementary-particle	1,289	1,409	97.8	97.8	-			-		
Nuclear	1,794	1,782	92.6	90.6	-			-		
Plasmas and fluids	930	1,104	63.7	64.1	Eng.	29.[illegible]	29.2	-		
Condensed-matter	4,064	4,157	82.6	80.5	Eng.	9.5	12.9	-		
Earth and planetary	567	712	79.4	77.9	Eng.	9.2	8.4	Astron.	5.3	8.0
Physics in biology	203	274	56.7	60.2	Biol.	23.6	25.5	Eng.	9.9	6.9
Optics	743	1,078	81.8	78.1	Eng.	11.6	15.0	-		
Acoustics	295	324	70.5	70.1	Eng.	20.0	22.8	Other	5.1	-
Miscellaneous	2,383	3,457	77.3	79.0	Eng.	8.7	5.3	Other	6.8	5.3
Subtotal astronomy	698	634	35.4	36.0	Astron.	58.5	57.4	-		

[a] Total with known employer.

The relations between subfields can be explored with Register data in two ways, first, by asking those working in a subfield at a certain time to list specific research areas in which they have varying degrees of scientific competence, and second, by examining longitudinal data for evidence of subfield mobility in both subfield of employment and that of first competence.

Table II.73 presents, for earth and planetary physics PhD's, the distribution of competence among other subfields. Astronomy is a prominent type of competence, but some additional analysis is required to see the pattern of subfield competence characteristic of earth and planetary physicists. This analysis requires the weighting of the citation frequency against the relative sizes of the cited subfields. The appropriate value of subfield relationship is obtained from the overall frequency of secondary competence weighted by the ratio of the populations of the subfield under consideration divided by that of the subfield of relationship. An alternative approach is that the relation rate is proportional to the intrinsic relation probability scaled by the corresponding density of available relationships; in other words, the rate depends on the transition probability times the density of states. The extreme right-hand column of Table II.73 gives the results, weighted and averaged.

TABLE II.73 Additional Competence of Earth and Planetary Physicists, 1970: Subfield Citation Frequencies by Level of Competence

Physics Subfield	Subfield PhD Population	Level of Competence (%) Greatest	Second	Third	Fourth	Weighted Average Citation (%)
Earth and planetary	710	66.0	51.6	39.5	37.9	49.0
Astronomy	630	6.7	7.8	11.6	10.6	11.3
Nuclear	1780	5.0	4.6	5.7	5.9	2.1
Elementary-particle	1410	2.2	2.5	3.7	2.9	1.4
Condensed-matter	4160	3.8	6.4	6.7	6.4	1.0
Atomic, molecular, and electron	1070	3.3	4.3	5.4	6.7	3.3
Plasmas and fluids	1100	3.3	4.7	7.1	6.4	3.4
Optics	1080	3.0	7.4	5.0	5.5	3.4
Miscellaneous	3460	5.9	10.1	13.5	14.5	2.3
No response (as percentage of 710)		2.0	3.8	7.9	16.9	

The pattern of intellectual relationship that emerges from the analysis of the earth and planetary groups is not surprising; what is remarkable is that it is a quantified pattern. Averaging the secondary competences and weighting by the overall distribution of physics activity, we find that earth and planetary physicists relate 57 percent to other earth and planetary specialties, 15 percent to astronomy specialties, and 13 percent to the combined subfields atomic, molecular, and electron physics; optics; and plasmas and fluids. Fifteen percent relate to other specialties.

A ranking of subfields can be constructed on the basis of degree of competence within and outside subfields. Table II.74 presents the results. The major feature of the table is that elementary-particle, nuclear, and condensed-matter physics are distinctly self-contained; plasmas and fluids; earth and planetary physics; and atomic, molecular, and electron physics overlap other subfields to an intermediate degree; optics and acoustics are strongly outward oriented. The evidence for real or latent subfield mobility is for the most part stronger for non-PhD's than for PhD's, a situation that would suggest lower inertia for the non-PhD resulting from a lesser commitment of expertise and project responsibility.

TABLE II.74 Competence Overlap

Physics Subfield	Competence in Other Subfields/Additional Competence in Subfield of Employment	
	PhD's	Non-PhD's
Condensed-matter	0.38	0.61
Elementary-particle	0.66	0.93
Nuclear	0.77	1.07
Earth and planetary	1.05	1.24
Plasmas and fluids	1.28	1.61
Atomic, molecular, and electron	1.30	1.90
Astrophysics and relativity	1.47	1.60
Acoustics	1.61	1.21
Optics	1.80	0.97
Physics in biology	2.33	3.08
Weighted average	0.90	0.88

So far in this Chapter we have dealt with horizontal distributions of characteristics in 1970. We now look at patterns of change between 1968 and 1970.

In the past two years (1968–1970) the number of PhD's working in earth and planetary physics grew from 567 to 712, a 25 percent increase in subfield population. Non-PhD's increased by 12 percent from 599 to 673. In 1964 there were 309 PhD's in this subfield. A

TABLE II.75 Age Distributions of PhD's in Earth and Planetary Physics

Age of Cohort in 1970	No. in 1968	No. in 1970	Cohort Change
< 27	2	5	3
27-31	57	157	100
32-36	141	169	28
37-41	128	140	12
42-46	80	94	14
47-51	73	71	-2
52-61	64	66	2
>61	22	10	-12
TOTAL	567	712	145

look at the age distributions and net changes is provided by Table II.75.

Seventy-one percent of the net growth resulted from new PhD's. The 1970 median age of the new entrants was less than 31; the median age of the subfield as a whole was 37.8 years in 1968 and 37.4 in 1970.

When we look at subfield changes between 1968 and 1970 we find a new characteristic—a large turnover of manpower has occurred. Only 55.6 percent of those working in earth and planetary physics in 1970 were working in it in 1968; 33.6 percent of the 1968 population apparently left the subfield. This trend is typical of other subfields, as Table II.76 shows. The first column shows the input of 1968 people to the subfield in 1970. Another input comes from persons who responded to the Register in 1970 but not in 1968; about 2600 of the 16,600 1970 PhD's in the physics section of the Register did not respond in 1968. Most of these people were in the less than 30-year-old cohort. However, we have 1968 data on 82 percent of the 1970 respondents, thus the mobility pattern in Table II.76 is representative.

In addition to the magnitude and direction of the interchange of scientists between earth and planetary physics and other subfields, the median age of each mobile element also appears in Table II.76. The age distribution of those who left is for the most part the same as for those who remained. The pattern of subfield relationships implied by actual changes in subfield work is remarkably similar to that found in the investigation of subfield competence of earth and planetary physicists (see Table II.73). In these mobility patterns we note that 56 percent of the subfield population remains in it as compared with the 49 percent average citation frequency of the subfield as an area of secondary competence. The most likely subfield move, astronomy, has a weight of 10.7 percent, much like the 11.3 percent probability for secondary competence in astronomy. On the whole, the pat-

TABLE II.76 Subfield Mobility of Earth and Planetary PhD's, 1968 to 1970

Physics Subfield of Employment	Entrants from 1968 Subfields: Percentage of 1970(%)	No.	Med. Age	Exits to 1970 Subfields: No.	Med. Age	Weighted[a] Distribution of Entrants(%)
Earth and planetary	55.6	323	38.5	323	38.5	55.6
Astronomy	9.5	55	35.4	37	37.7	10.7
Nuclear	4.0	23	35.2	2	32.5	1.6
Elementary-particle	4.8	28	33.0	15	37.7	2.4
Condensed-matter	4.5	26	38.5	17	40.0	0.8
Plasmas and fluids	4.0	23	36.2	7	35.5	2.6
Atomic, molecular, and electron	3.3	19	39.2	9	39.5	2.2
Optics	3.3	19	39.9	15	39.0	2.2
Acoustics	0.3	2	45.5	2	55.5	0.7
Astrophysics and relativity	1.4	8	32.5	6	42.5	4.0
Miscellaneous	9.5	55	44.7	52	40.0	2.0
Total, longitudinal Register		581(1970)		486(1968)		
Median age			38.3		38.6	
Earth and planetary interchange						
Entrants		258				
Departures				163		
Total horizontal Register		712		567		

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[a] Derived by weighting figures in this column by the distribution of physicists among subfields.

tern of interchange of workers is similar to the pattern of overlapping subfield competence.

We have ranked the physics subfields in Table II.77 according to the longitudinal probability of remaining, which we have called subfield solidarity. For comparison with horizontal patterns of secondary scientific competence, we have also calculated a mobility overlap area in a manner that correspon[illegible]ally to the competence overlap area shown for the subfie[illegible]in Table II.74. Again, the general features of the longitudinal and horizontal distributions are much the same. We have taken this analysis one step further and looked at the changes in first competence between 1968 and 1970. The results are tabulated in Table II.78 and the now familiar sequence of subfields again results. Three categories emerge: First, the independent, static category always contains elementary-particle, nuclear, and condensed-matter physics. An intermediate category consists of plasmas and fluids; earth and planetary physics; and atomic, molecular and electron physics.*

TABLE II.77 Subfield Mobility 1968 to 1970: Ranking by Subfield Solidarity

Physics Subfield	Solidarity[a] (%)	Mobility[b] Overlap(%)	1968, 1970 Samples	
			N = 1968	*N* = 1970
Elementary-particle	84.1	0.19	1063	1209
Nuclear	83.2	0.20	1390	1673
Condensed-matter	81.1	0.23	3245	3755
Plasmas and fluids	68.2	0.47	836	824
Acoustics	66.5	0.49	257	249
Atomic, molecular, and electron	56.2	0.78	283	925
Physics in biology	55.7	0.78	201	180
Earth and planetary	55.6	0.78	581	486
Astrophysics and relativity	42.1	1.38	195	121
Optics	37.4	1.70	847	637
Miscellaneous	48.7	1.04	2718	1883
Physics (weighted average)	66.2	0.51		
Astronomy	80.7		483	657
Total 1968 and 1970 samples			12,599	

[a] Subfield unchanged, 1968–1970, as a fraction of 1970 total.

[b] $\frac{\text{Newcomers}}{\text{Those Who Remained}} = \frac{1 - \text{Solidarity}}{\text{Solidarity}}$.

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*With a minor deviation in the measured first competence mobility.

TABLE II.78 First Competence Mobility: Ranking by Subfield

Physics Subfield	Solidarity(%)[a]	Mobility Overlap[b]
Elementary-particle	67	0.43
Condensed-matter	66	0.52
Nuclear	66	0.52
Plasmas and fluids	54	0.85
Earth and planetary	50	1.00
Acoustics	44	1.27
Physics in biology	43	1.32
Optics	42	1.38
Atomic, molecular, and electron	40	1.56
Astrophysics and relativity	36	1.78
Astronomy	54	0.85
Miscellaneous	38	1.63

[a] Subfield unchanged, 1968–1970, as fraction of 1970 total.

[b] $$\frac{\text{Newcomers}}{\text{Those Who Remained}} = \frac{1 - \text{Solidarity}}{\text{Solidarity}}$$

A third category, with large overlap and mobility, includes opt[illegible] and astrophysics and relativity. Acoustics and physics in biolo[illegible] show rather more overlap than mobility, placing them somewhere between intermedian and high-overlap mobility categories. The assumed relation between competence and mobility is well borne out in the data: The susceptibility implied by the large subfield overlap is matched by a significant flow of manpower over time.

Table II.79 presents the pattern of change based on first competence for earth and planetary physicists. The turnover of 52 percent is comparable with the average citation of competence outside the subfield, 51 percent, the complement of the average internal citation probability of 49 percent in Table II.73. The directionality of competence mobility with respect to the other

TABLE II.79 First Competence Mobility: Changes for PhD's in Earth and Planetary Physics, 1968–1970

First Competence in 1968	First Competence in 1970		
	Earth and Planetary	Other	1968 Total
Earth and planetary	231	234	465
Other	269		
1970 Total	500		12,511

subfields is the same as that given in the static overlap pattern and, as we have seen, the same as that manifest in actual subfield mobility.

We next examine the recent growth pattern of earth and planetary physics. Under normal conditions we would expect growth to take place in a pattern commensurate with the pattern of overlap. The interchange among subfields reflects this pattern, but recent growth does not. In Table II.80, expectations are compared with changes from 1968 to 1970. The normal entering distribution, column 3, is proportional to the product of the total overlap with the other subfields, column 2, and the size of populations in those subfields, column 1. These data come directly from Table II.73. Only the relative size of expected entering groups has significance, and we have set a numerical absolute value of 30 for the grouping of plasmas and fluids; optics; and atomic, molecular, and electron physics for ease of comparison with the actual net flux of PhD's given in column 4. Comparison of normal and actual patterns of flux show a large number of people are coming from astronomy, three times the number expected on the basis of overlap-circulation characteristics. The flow of PhD's from traditional physics subfields, elementary-particle, nuclear, and condensed-matter physics, is only 50 percent higher than might be expected for isotropic growth. The importance of the relationship with astronomy was suggested in the analysis of the elite group of earth and space scientists at the beginning of this chapter. The flow of manpower from the traditional physics subfields is not sufficiently large to indicate substantial relief of the stress of limited resources that is said to exist. Although the data suggest no anomalous impedance to mobility, there is no sign of an enhancement that might be desirable.

To what extent is employer mobility a factor in subfield mobility? How much research redirection takes place in periods of unchanged institutional affiliation compared with changes concurrent with employer mobility? Table II.81 shows subfield mobility ac-

TABLE II.80 Normal and Actual Flux Distributions by Source

Source	Source Population	Overlap Distribution	Normal Entrant Distribution[a]	Actual Net PhD Entrant Distribution
Astronomy	630	11.3	6	18
Plasmas and fluids; atomic, molecular, and electron; and optics	3250	11.1	30	30
Elementary-particle, nuclear, and condensed-matter	7350	4.5	27	43

[a] (Population) × (Overlap), in arbitrary units.

TABLE II.81 Earth and Planetary Physics Subfield Mobility with and without Concurrent Employer Change: Number of PhD's and Median Age

Employer 1968–1970	E&P 1968 Number	Left E&P	E&P Both 1968 and 1970	Entered E&P Number	E&P 1970 Number	Net E&P Change
University	169	54	115	87	202	33
Industry	77	28	49	61	110	33
Government	101	31	70	28	98	-3
Research center	58	14	44	21	65	7
Other	9	5	4	5	9	0
Unchanged, subtotal	414	132	282	202	484	70
Median age	39.3		39.0		39.2	39
Changed, subtotal	72	31	41	56	97	25
Median age	32.4		33.5		33.9	33
Total	486		323	258	581	95
Median age	38.6		38.5		38.3	

cording to type of employing institution. Of 589 earth and planetary physics PhD's in 1970, 16.7 percent had changed employer since 1968; half of these 97 PhD's were under 34 years of age, and 58 percent of this employer mobile group entered earth and planetary physics for the first time. The other 42 percent had been working in this subfield before they changed jobs. The remaining 83.3 percent of the 1970 earth and planetary physicists were still employed by the same type of institution as in 1968. This employer static group was divided approximately 42 percent to 58 percent between newcomers and older established scientists.

Although employer mobile PhD's were somewhat more likely to have changed into earth and planetary physics than employer static ones, such a large age difference appears between those who changed and those who were static that typical early career effects account for employer changes more than would effects resulting from the subfield.

The composition of the 1970 earth and planetary physics PhD group is summarized in Table II.82.

Among the employer static new earth and planetary physicists, industry showed the largest fractional growth (55 percent), universities somewhat less (43 percent), and other types of employment little increase.

If in the future one anticipates a larger commitment to earth and planetary physics as a result of employer mobility, the pattern of employer interchange between 1968 and 1970 should be examined. Table II.83 records the employer changes of earth and planetary physicists from 1968 to 1970. One seventh (14.7 percent) made such changes; of these, three fourths (73 percent) were university related—young PhD's leaving and some older ones returning.

TABLE II.82 Mobility Composition of Earth and Planetary Physics PhD Population

Source	Number	Percent	Median Age
New PhD's	145	20	31.5
Employer mobile PhD's	97	13	33.9
Employer static PhD's			
New to earth and planetary physics	202	28	39.0
In earth and planetary physics in 1968	282	39	39.2
TOTAL	726	100	37.4

The pattern of interchange between the university and other types of employment appears in Table II.84.

TABLE II.83 Changes in Employer, 1968 to 1970, for 502 PhD's Working in Earth and Planetary Physics: Number and Median Age[a]

1968 Employer	1970 Employer University		Industry		Government		Research Centers		Other		Total 1968 Employer Distribution	
	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age	No.	Age
University	176	38.4	9	30.7	11	33.5	8	32.0	4	29.4	208	37.2
Industry	4	33.5	79	41.2	-		2	34.5	2	40.5	87	40.9
Government	8	34.5	1	49.5	104	39.9	2	40.5	-		115	39.7
Research center	2	34.5	1	45.5	4	45.5	58	39.7	1	33.5	66	39.7
Other	8	31.8	2	44.5	3	29.5	2	36.5	11	39.5	26	34.5
Total 1970 distribution	198	37.7	92	40.7	122	39.4	72	38.5	18	36.5	502	38.9

[a] 74 changed employment; 428 remained in the same type of employing institution; total with employment known in both years was 502.

TABLE II.84 University and Other Employment Interchanges in Earth and Planetary Physics, 1968 to 1970

1968 Employer	1970 Employer University	Other
University	176	32
Other employment	22	272

II.2 Samples of Special Populations

II.2.1 CAREER CHOICES OF TALENTED MALE STUDENTS

At the start of the 1960's one sometimes heard it argued that we could and should greatly expand our national production of scientists by encouraging a larger proportion of the talented young people to choose scientific careers. Such arguments were based on the belief that of the population of people with the necessary aptitudes, only a minute fraction was going into science. Although the feeling that the United States needed more scientists was greatly muted by the end of the 1960's, one heard increasingly often the complaint that the best students were turning away from science. The bases for these arguments and complaints were sometimes merely subjective impressions, sometimes extensive statistics, such as those of Harmon* correlating IQ scores with the obtaining of doctorates, or those of Nichols† on the study plans and career aspirations of National Merit Scholarship semifinalists. Having access to information on the life-long career activities of a group of people selected for academic aptitude with unusual care and thoroughness at the time of their graduation from high school, and without bias among fields, we undertook to investigate the distribution of these people among careers and ways in which this distribution might have changed during the last several decades.

II.2.1.1 *Nature of the Sample*

The Summerfield Scholarships, established at the University of Kansas in 1929, are awarded each year to male graduates of high schools in the state on the basis of competitive examinations followed by person-by-person scrutiny. Occasionally they are awarded also to students already at the University. The awards have high prestige and are much sought after; they are made on the basis of scholarly promise alone, without bias for or against any field of study and without regard to the financial resources of the student. After the award is made, the student's financial resources are investigated and he is supplied with whatever supplemental assistance he needs to pursue his studies without financial worry. If, as is nearly always the case, the student's university work fulfills expectations, the scholarship is renewed each year until he graduates.

Each year the University issues a list of all alumni of this program, giving for each alumnus any advanced degrees he has received and his present employment.§ From 1933 to 1969 there were 509 alumni, of whom 18 had died and 13 were incompletely traced. Figure II.14 shows the number of Summerfield graduates by year of bachelor's degree. The numbers have fluctuated considerably from year to year, because of secular trends and because the number of

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*Harmon, L. R., *Science, 133,* 679 (1961).

†Nichols, R. C., *Science, 144,* 1315 (1964).

§Pamphlets titled *University of Kansas Summerfield Scholars* issued each April by the University of Kansas.

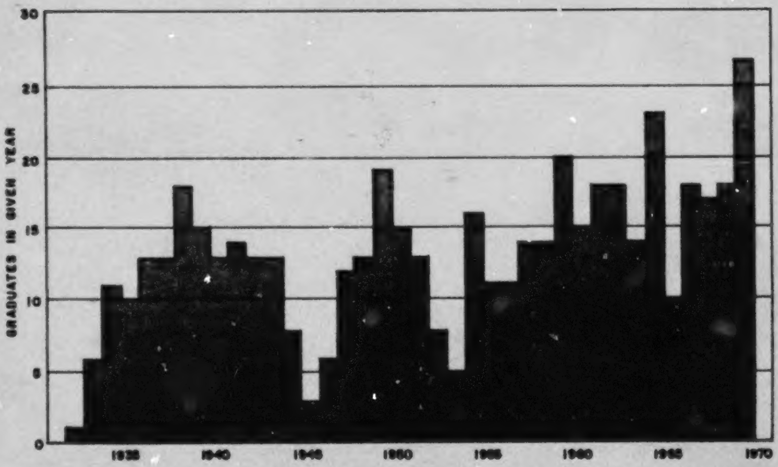

FIGURE II.14 Graduates of the Summerfield Scholar program by year of graduation.

scholarships that can be awarded in any year depends on the financial needs of the recipients. As the average number of scholars per year has risen only slightly from the mid-1930's to 1969, while the enrollment at the University has more than quadrupled during the same interval, it is reasonable to guess that the standards have risen at least slightly, though perhaps not greatly, as alternative scholarships and the like may have become more available. According to informal estimates by administrators and others familiar with the program, these alumni are probably typical of about the top 3 or 4 percent of graduates of the University of Kansas (henceforth referred to as KU). To gauge what this means on an overall national scale one must rate KU bachelor's degree holders relative to those of other institutions. According to a recent compilation,* KU baccalaureates accounted for 373 of 80,978 U.S. PhD's in the years 1960-1966 (a fraction 0.0046). As the 1968-1969 enrollment was 16,964, compared with a national total of 5.77 million in four-year institutions (fraction 0.0029), it is probably conservative to conclude that the Summerfield Scholars have an ability level characteristic of the top 3 or 4 percent of U.S. college graduates.

It is interesting to compare the characteristics of this sample with those of Nichols's† sample of National Merit Scholarship semifinalists. This category of students comprises a rather larger

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Doctorate Recipients from United States Universities 1958-1966. (NAS Publication 1489) Washington, D.C.: National Academy of Sciences, 1967.

†Nichols, R. C., *Science, 144,* 1315 (1964).

fraction of college enrollments than the Summerfield Scholars do of KU enrollment; however, their selection process, based on test scores alone, is less careful and is not subject to modification after entrance into college. Only a small fraction of the National Merit Scholarship semifinalists applying for Summerfield Scholarships receive them. More serious, however, is that Nichol's data consisted only of career choices, expressed before entering college, and major fields of undergraduate study, whereas the Summerfield data refer to career positions into which the men settled a number of years after graduation. Nichols also gave some figures for another sample, of somewhat lower average ability, on changes in career choice between the year of entry into college and the year of graduation. These figures, unfortunately given for only one class, show such large changes that one is uncertain whether to interpret secular changes in career choices expressed on entering college as reflecting ultimate careers or as reflecting improved counselling.

II.2.1.2 *Statistics on Eventual Careers*

Figure II.15 shows the percentages of Summerfield Scholars graduating in various time intervals who have gone into each of several professions. Cross-hatched bars represent career positions, blank bars represent graduate or professional school students, and the bars with a question mark represent graduates with undergraduate majors in the field indicated but for whom no data on present activity are available. (Past experience suggests that most of these are actually graduate students.) The data shown by the cross-hatched bars were based on the following definitions of the various professional fields:

1. Natural science and mathematics. Includes all those whose titles suggest that they teach science at the college level or engage in pure or applied research or its supervision. Psychology is included but not anthropology.
2. Engineering. Includes all those whose titles suggest that they perform or supervise engineering work or teach engineering.
3. Medicine. Includes MD's engaged in any medicine-related work, dentistry, and possibly one or two other fields.
4. Law. Includes those engaged either in private law practice or as attorneys for business or public organizations.
5. Government administration. Includes administrators in national, state, or local agencies, other than military personnel.
6. Business. Includes administrators in private business organizations, exclusive of attorneys and those involved solely in research or engineering work. Includes accountants.
7. Social science teaching and research. Includes college faculty in social sciences, history, and anthropology and scholars in these fields employed elsewhere (but not in high school teaching).
8. Humanities. Includes college faculty in literature, philosophy, and the like, independent writers, etc., but not clergy, high school teachers, artists, or musicians.

9. Miscellaneous: Includes high school and grade school teachers, educational administrators at all levels, artists and musicians, military personnel, clergy, journalists, architects, and pharmacists.

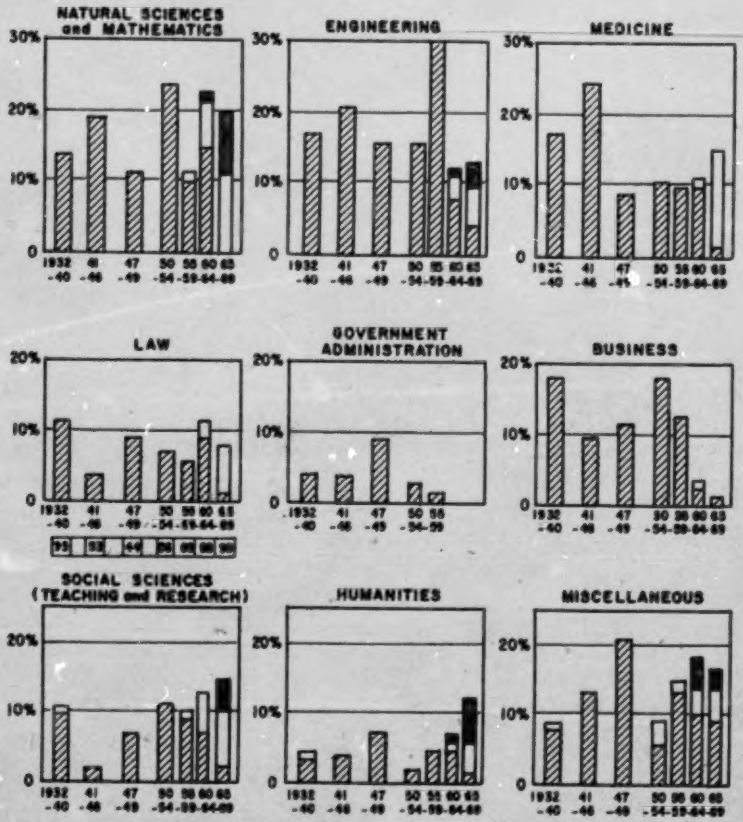

FIGURE II.15 Percentages of Summerfield Scholars, graduating in various time intervals, who have settled in various professions. Years of graduation are given at the bottom, the numbers of graduates in the various periods being

1932-40:	95	1955-59:	69
1941-46:	53	1960-64:	88
1947-49:	44	1965-69:	90
1950-54:	56		

Shaded bars are men in jobs, unshaded bars are graduate and advanced professional students, and question marks are uncertain cases, classified by field of degree.

To the extent possible, graduate and professional students were assigned to one of these categories. Obviously students assigned to one could be expected sometimes to go into careers in another. Such a change is especially likely among students in the social sciences, who will often enter government or business. Medical students, in marked contrast, nearly always continue in medicine. It should be noted that the career distributions for the 1932-1940 classes were made from data available in the early 1950's; those for subsequent classes were made from 1969 or 1970 data. A comparison of the early and recent data for the 1941-1946 sample showed few career changes except for the expected migration, with increasing age, of a minority of the scientists and engineers into business or other administration.

Figure II.16 is an attempt to compare the Summerfield Scholarship data with those of Nichols on National Merit Scholarship semifinalists. The wide bars at the right and left of each diagram represent the Summerfield data for students graduating in each of two decades; as before, cross-hatching represents jobs, open spaces graduate or professional students, and question marks uncertain cases classified by undergraduate major. Nichols's data are represented in part by the narrow bars in between, which show pre-enrollment (freshman) choices of undergraduate major subject, averaged for the college *entry* years shown. The dumbbells represent the corresponding pre-enrollment preferences for eventual careers. As the change in career choices from freshman to senior years was available for only one class (entry 1957, graduation 1961), no precise three-year averages can be given for the senior year choices; instead, the lines with x's at the ends have been drawn in the 1958-1960 column at a height equal to the height of the dumbbell times the 1957-1961 ratio of senior-year to freshman-year preferences. The narrow bars for medicine refer to those planning enrollment in premedical curricula; no enrollment bars are given for law, because it is not an undergraduate option; all majors in social sciences (like the graduate students in Figure II.15) were placed under social science teaching and research; humanities were treated similarly.

So far we have concentrated on changes with time, and the Summerfield data are too sparse to permit subdividing them by field of science as well as by time period. If all data for classes $\geq$ 1950 are taken together, we find that of the 50 or 60 men assigned to natural science in Figure II.15, at least 15 have entered physics. Two more, both with bachelor's degrees in engineering physics, are members of the American Physical Society (APS). If we restrict attention only to those in nonstudent jobs, the ratio is 13 or 14 of 33 or 34. Clearly physics has been getting more than its share of those especially gifted men. However, the data are not sufficient to refute the speculation that in the last decade physics has drawn fewer such men than, say, biology. Of the 13 in what are clearly physics jobs, the two oldest are APS Fellows; the others (PhD's since 1962, except possibly for one undated case) are a little young for this rank; only one is neither a PhD nor a graduate student and probably is finishing a thesis.

A similar analysis of Summerfield graduates prior to 1950 shows 11 physicists from among 28 natural scientists. Of the 11, all but one have PhD's and six are APS Fellows.

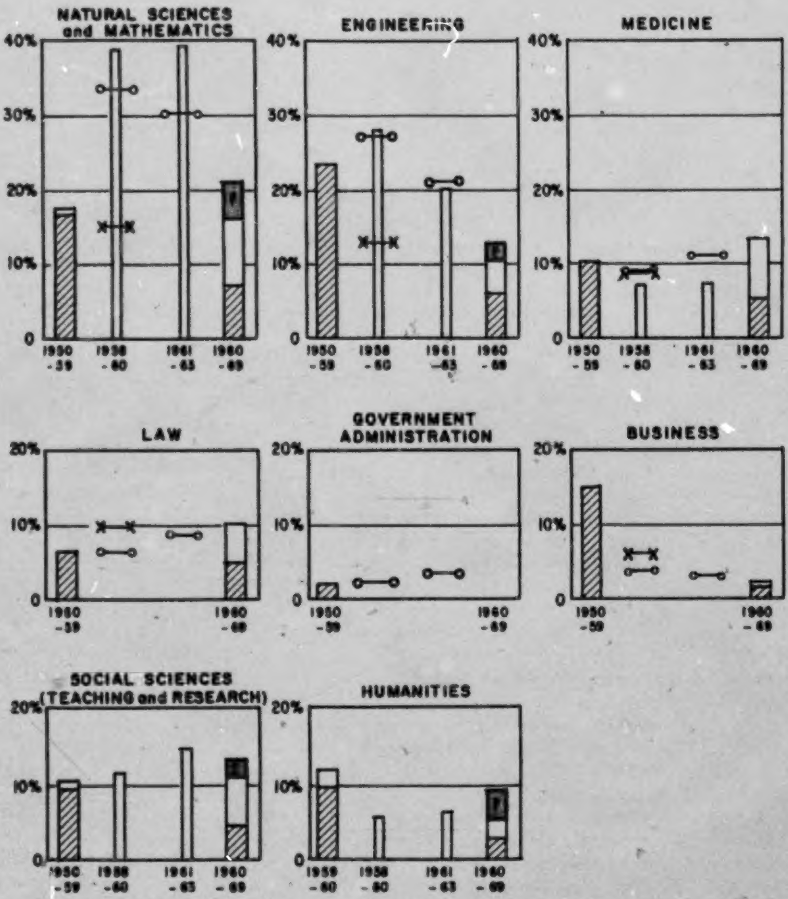

FIGURE II.16 Comparison of Summerfield-Scholar (SS) and Merit Semifinalists (MS, from Nichols) data. The broad bars at the left and right are the SS data of Fig. II.2, averaged 1950-59 and 1960-69, respectively. The narrow bars in between are the intended undergraduate majors of the MS samples. The dumbbells are career intentions at time of entry into college; the lines with x's are these multiplied by the ratio of senior to freshman intentions for the 1957-61 class.

II.2.1.3 *Conclusions*

In general the two sets of data in Figure II.16 appear reasonably compatible, when one makes allowance for their obvious limitations, for example, that increasing age increases the probability of involvement in business and government administration or that not all students planning to enter medicine enroll in an explicitly premedical major. Neither set of data gives convincing support for Nichols' implied conclusion that talented students are becoming less likely to adopt careers in basic science. The slight decrease in the level indicated by the dumbbells in Figure II.16 between 1958-1960 and 1961-1963 could well have resulted from improved counseling, that is to say, from a decrease in the difference between the dubbell and x levels, or the ultimate career choice. In regard to engineering, however, all three types of data suggest that Nichols may well have been correct in concluding that the inclinations of talented students toward this field is decreasing. If this finding is true—and better statistics would be needed to establish it with certainty—it could have important implications for the role of pure-science fields in the economy. It would partially nullify the argument, often made currently, that the increasing sophistication of engineering education is causing engineers (especially PhD's) to take over the role formerly played by physicists as the best reservoir of talent for technological tasks involving new and unfamiliar ideas. Although engineering training may be improving, this improvement may be offset by a decreasing number of the most highly talented youth who elect it; if so, *it may be as necessary now as in earlier decades to draw on the pure scientists for technological innovations.*

The data on physicists in the Summerfield sample, given in the last paragraphs of Section II.2.1.2, suggest that the ability level of the sample is about that of APS Fellows and show that *among natural science students at this ability level, nearly a third have entered physics in the last few decades.* (In the Nichols sample, from one half to a little less than one third of the National Merit Scholarship semifinalists planning majors in natural science fields planned to major in physics.) But a decline in enrollments in physics in the last few years, relative to other sciences, is suggested by the Nichols data and cannot be refuted by the Summerfield data.

II.2.2 PHYSICS DOCTORATES WHO HAVE LEFT PHYSICS

A significant number of people, after beginning a career in physics, even with a doctorate, eventually move into other sciences or engineering or into entirely nonscientific fields. Projections of the balance between supply and demand in future years, such as those attempted in Chapter 12 of Volume I of *Physics in Perspective,* need to take into account this portion of the population. In planning both the scale and nature of graduate education in physics, one would like to know, among other things, to what extent these people are misfits who should never have studied physics and to what extent they represent an important channel for cross-fertilization of other professions, scientific, administrative, or educational. The study we report here was a highly preliminary one designed to explore one possible means of getting answers to some of these questions.

Examination of a list of nearly 500 people who had received doctorates in physics from the Massachusetts Institute of Technology (MIT) between 1935 and 1959 revealed a number who, from their addresses or other information, were not in academic physics departments in 1970. These people were queried by mail regarding the way in which their careers have developed and the relation, if any, of their physics training to their present work. Replies received from slightly less than half indicated the following:

1. Only about one fifth said that more than half of their present work involved physics by extrapolation; therefore, one can guess that approximately one fourth of the MIT physics doctoral alumni of this vintage have moved into work that is primarily outside the scope of physics.
2. About one fourth of the responses were from presidents or vice presidents of companies working in communication, data processing, geophysics, and space and defense systems. This number extrapolates to about one in 14 of all physics PhD alumni. As expected, these men were somewhat older than the others, having received their doctorates some 25 ± 6 years previously; it had been 14 ± 7 years since the majority of their work involved physics. But all thought that their physics background was helpful to them in their present positions.
3. A somewhat larger fraction—corresponding to about one in nine of all the alumni studied—were now directors of research or engineering development in high-technology companies. They were somewhat younger than the group described in 2 above, 20 years on the average having elapsed since receiving the doctorate, and the present work of about 30 percent involved physics.
4. A third large group—extrapolating to about one in 12 of the alumni—were working in universities but not in physics departments.
5. A fourth and somewhat smaller group was self-employed, doing technical consulting for industry and the government. Approximately half of their work was still related to physics.

The greater proportion of alumni, who have moved out of physics, is shown in Table II.85. Actually, the figures in the table probably reflect two effects. One is that motion away from physics is cumulative: opportunities to move into other professions, particularly administration, increase with the years, and once one has left physics one is unlikely to return. Another factor, however, has been the evolution of the physics enterprise. The vast expansion of university staffs and industrial physics research in the 1950's and 1960's created a great demand for physicists, including senior ones, which may have acted to keep a larger proportion of people in the profession than was the case for the same age groups in earlier years. In the 1970's a reversal of this trend may well occur. Interestingly, none of the persons surveyed spent more than six years in a physics department after receiving the PhD.

A valuable product of the survey, though one rather difficult to convey in a brief summary, was the collection of free-language comments by the respondents. In these comments, and in their responses to questions on the value and relevance of their physics education, the overwhelming majority affirmed that their education in physics research had been of value in their careers. Moreover, three fourths of them said that their training in physics also had been of value to them for reasons other than its relevance to their work. Although research training was sometimes cited for its value in teaching methods of thought and working philosophy that may be applicable to other types of problems, there was an even stronger emphasis by many respondents on the exhortation that graduate training in physics should not be allowed to be too specialized. Courses in classical theoretical physics were the ones most often cited as being of particular value.

This study, incomplete though it is, gives some support for the view that doctoral training in physics, if not too narrowly specialized, can serve as a useful one of many possible channels for providing the nation with a diverse and innovative population of educational and industrial administrators.

TABLE II.85 Estimates of the Migration of MIT Physics Doctorates from Physics, as of 1970

Year of PhD	Total Alumni	Estimated No. Who Left Physics	Fraction Leaving
1935-1940	62	36	0.58
1941-1945[a]	56	14	0.25
1946-1949	73	23	0.32
1950-1954	160	50	0.31
1955-1959	139	27	0.20
Total, 1935-1959	490	150	0.31

[a] The World War II years are separated, even though this makes the time intervals in the table unequal in duration.

III

DATA ON FUNDING AND COSTS

III.1 General Survey of the Various Sources of Support for Physics Research

III.1.1 SOURCES OF INFORMATION AND DIFFICULTIES IN THEIR USE

The chapters of this report dealing with the funding of physics are all concerned with the support of research in physics, or of activities directly related to the research enterprise, as distinguished from the role of physics in such activities as general education, developmental engineering, and industrial production. Even so, ambiguities can arise in regard to how research is to be distinguished from these other activities and, of course, where the lines are to be drawn separating research in physics from research in other sciences and engineering. So perhaps we should begin this chapter with a few words about the delineation of our subject.

The conventional categories of research, for example, in the tables published by the NSF in its periodic report, *Federal Funds for Research, Development, and Other Scientific Activities*, are basic research, applied research, and development. Basic research is defined as "exploration of the unknown...primarily motivated by the desire to pursue knowledge for its own sake." Applied research is described as "finding the means to meet a recognized need." Development is defined as "systematic use of knowledge...directed to the production of useful materials, devices, systems, and methods." Although the distinction among these three activities provides a useful way of ordering one's thinking, it is difficult to make these distinctions precise or quantitative, because they depend— especially in the case of basic versus applied research——on knowing motivation. What is applied research in the mind of an administrator or official of a granting agency may be basic research to the person doing the work, or vice versa. In recording their use of funds, different agencies may draw the dividing line in different places. For these and related reasons, we have chosen, in all our collection and analysis of funding data, to concentrate on research, without attempting to distinguish basic from applied, and to define it in the following way: Research is the generation of new knowledge that, soon after its generation, becomes a part of the publicly available archive of knowledge. A useful corollary of this definition is that research activity in physics can be studied through the primary journals, books, and other publications of the field.

The overlap of physics with other scientific and engineering fields is, of course, substantial. The nature and extent of this overlap are discussed in some detail in Section IV.1.1, in which we show that the citation structure of the scientific and technical literature can be used to provide a reasonably logical and objective definition of the boundary between two adjacent fields. Although application of this technique to the separation of funding for physics from that for other fields would be prohibitively laborious, it can be used, as described there, as a check on the reasonableness of the intuitive decisions on what is and is not physics that one must make in the course of assembling data. A few checks of this sort that we have made have given us confidence that the definitions of physics that we have used in the presentation of our data are reasonably consistent with the objective definition.

Although we have tried to apply our own definitions of research, physics, and even support whenever possible and to do so consistently, most of our data-gathering activities have had to rely extensively on the records of various organizations, particularly government agencies, and on the categories in which these records are kept. Because of the difficulties with definitions, to which we have just alluded, one is entitled to view all such data with some suspicion, and one would like to be able to check data derived from one source against those derived from a more or less independent source. The sources from which we have been able to obtain useful data on funding are the following:

1. Detailed records of federal agencies, studied with the aid of officials of these agencies. These records have been our principal source of information about the funding of physics by the DOD, NSF, AEC, and NASA.
2. Government publications prepared for other purposes. These include, in particular the *Federal Funds* series* and the annual *Statistical Summary of the AEC Physical Research Program.*
3. The acknowledgment of research support usually made in research articles in journals.
4. Queries made to small but carefully selected samples of universities and industrial research organizations.
5. Mention of government support made by respondents to the questionnaire for the National Register of Scientific and Technical Personnel.

**Federal Funds for Research, Development, and Other Scientific Activities*, issued periodically by the NSF.

The data obtained from source 1 are described in Section III.2. Those obtained from source 4 are discussed in Section III.3 and III.4 and those from sources 3 and 5 are the subject of the paragraphs immediately following.

III.1.2 NONDOLLAR DATA RELEVANT TO THE DISTRIBUTION OF SUPPORT

III.1.2.1 *Distribution of Support Acknowledged in Journal Articles*

It is a fairly consistent custom in the physics literature for papers reporting work that has received support from sources outside the institutions with which the authors are affiliated to contain an acknowledgment of this support. By counting such acknowledgments one can get a good deal of information about the sources of support for work performed in various types of institutions and its distribution among the subfields of physics. The information is incomplete, of course, for the dollar amount is never stated and the relative contributions of different sources, when there is more than one, are not indicated. However, if reasonable allowance is made for these ambiguities, the results can provide a useful check on funding information obtained in other ways.

In our survey, members of the Statistical Data Panel examined all the articles published in a two-month period in 14 AIP journals and 29 non-AIP journals. The months used depended on availability, but all issues were published between mid-1969 and mid-1970. The total number of papers examined was 1200, 834 from AIP journals and 366 from non-AIP journals. Since the total number of physics papers published by U.S. authors in a year is estimated to be about 14,000,* the sample represents slightly less than one tenth of the annual U.S. output of published physics papers. The distribution between AIP journals and non-AIP journals (mostly European) in the sample was roughly consistent with the known publication pattern of U.S. work.†

The survey was conducted in the following way. All papers in each issue selected were examined. Only those papers that were regarded as physics and the authors of which were affiliated with an institution in the United States were counted. For each physics paper a subfield assignment was made and the nature of the performing institution and sources of support acknowledged were recorded. If no external source of support was acknowledged, support was credited to the authors' institution. Many complicated cases were encountered involving papers in which the authors represented several institutions, multiple sources of support were mentioned, and partial support was acknowledged. To increase the manageability of the data, the Panel chose as the least count 0.5, so that no paper

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***Physics in Perspective*, Volume II, Part B, Figure XIV.32 or Table XIV.11.

†Compare, for example, Table IV.3 (in Chapter IV), also *Physics in Perspective*, Volume II, Part B, Table XIV.9.

was divided between more than two performer-support combinations, with omissions, when necessary, being assigned to the last-mentioned institutions or sources. A somewhat arbitrary decision on division of support among institutions or sponsors was required for about half of the papers.

The results are presented in a series of tables, which record the counts of various subfield-source-performer combinations. Table III.1 shows acknowledged sources of support by subfield. Table III.2 is a similar table but includes only research performed in universities. Table III.3 shows the institutional affiliation of authors of journal articles by subfield. Tables III.4, III.5, and III.6 show the patterns of support of the three major federal funding agencies for physics research by performing institution and subfield. The general picture resulting from these tables will be compared in Figure III.1 with that based on statements about government support made by respondents to the National Register. Both types of figures, which suffer, of course, from lack of calibration in dollars, will be compared with dollar data obtained from records of government agencies in the following subsection.

TABLE III.1 Acknowledgment of Support in Journal Articles, by Subfield[a,b]

Source of Support	A&R	AME	EP	NP	P&F	CM	E&P	Bio-phys	Acoust	Opt	Other Phys.	Total	Percent
University	2.5	29.0	19.5	21.5	15.5	65.0	4.0	1.0	2.0	8.0	19.5	187.5	15.6
DOD	10.0	50.0	18.5	13.0	17.0	126.5	14.5	-	13.0	18.0	13.5	294.0	24.5
NASA	4.5	20.0	1.0	2.0	7.5	14.5	26.5	-	2.0	7.0	6.5	91.5	7.6
AEC	-	19.0	54.0	72.5	15.0	77.0	3.0	-	-	3.5	6.0	250.0	20.8
NSF	5.0	28.0	21.5	22.5	13.0	51.0	8.0	-	1.0	7.0	11.0	169.0	14.1
Other gov.	1.0	7.0	2.0	2.0	2.5	25.0	-	4.0	1.0	6.5	3.0	54.0	4.5
Industry	-	14.0	-	0.5	3.5	76.0	1.0	-	5.0	19.0	12.5	131.0	11.0
Nonprofit	-	1.5	1.0	0.5	-	5.5	1.0	-	-	2.5	0.5	12.5	1.0
Private	-	1.0	2.5	2.5	0.5	2.0	-	-	-	-	1.0	9.5	0.8
TOTAL	23.0	169.5	120.0	137.0	74.5	442.5	58.0	5.0	24.0	71.5	73.5	1200.0	100.0

[a] Entries are numbers of papers sampled acknowledging support from the given source, with occasional fractional allocations as discussed in the text.

[b] Subfield abbreviations used are A&R, astrophysics and relativity; AME, atomic, molecular, and electron physics; EP, elementary-particle physics; NP, nuclear physics; P&F, plasmas and fluids; CM, physics of condensed matter; E&P, earth and planetary physics; Biophys, biophysics; Acoust, acoustics; Opt, optics.

TABLE III.2 Sources of Support Acknowledged in Journal Articles from Universities, by Subfield[a,b]

Source of Support	A&R	AME	EP	NP	P&F	CM	E&P	Acoust	Opt	Other Phys.	Total	Percent
University	2.5	29.0	19.5	21.5	15.5	65.0	3.0	2.0	7.5	20.5	186.0	24.5
DOD	10.0	37.0	17.5	7.5	11.5	88.0	4.0	5.0	9.0	9.0	198.5	26.1
NASA	2.5	11.5	-	0.5	4.0	10.0	18.0	1.0	4.5	2.5	54.5	7.2
AEC	-	7.5	42.0	31.5	7.0	26.0	2.0	-	1.5	1.5	119.0	15.7
NSF	5.0	28.0	21.5	22.0	13.0	51.0	7.0	1.0	6.5	12.0	167.0	22.0
Other gov.	-	1.5	-	-	1.5	10.0	-	1.0	1.5	4.0	19.5	2.6
Industry	-	-	-	-	-	1.0	-	-	-	-	1.0	0.1
Nonprofit	-	1.5	-	0.5	-	2.5	-	-	0.5	-	5.0	0.7
Private	-	1.0	1.5	2.5	0.5	2.0	-	-	-	1.0	8.5	1.1
TOTAL	20.0	117.0	102.0	86.0	53.0	255.5	34.0	10.0	31.0	50.5	759.0	100.0

[a] Entries are numbers of papers, as in Table III.1.

[b] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

TABLE III.3 Institutional Affiliation of Authors of Journal Articles[a,b]

Type of Institution	A&R	AME	EP	NP	P&F	CM	E&P	Biophys	Acoust	Opt	Other Phys.	Total
University	19	119	104	86	54	255	34	4	10	31	47	763
Industry	-	18	1	2	7	87	7	-	7	20	16	165
Nonprofit	-	4	-	3	2	14	-	-	-	6	-	29
Gov. in-house	2	13	2	6	4	35	8	1	5	10	4	89
Federally funded research and development center	1	17	14	39	8	57	11	-	2	4	6	159
TOTAL	22	171	121	136	74	448	60	5	24	71	73	1205

[a] Entries are numbers of papers, as in Table III.1

[b] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

TABLE III.4 Distribution of Papers Acknowledging Support by the Department of Defense, by Subfield[a,b]

Institution Performing Reported Work	A&R	AME	EP	NP	P&F	CM	E&P	Acoust	Opt	Other Phys.	Total
University	10.0	37.0	17.5	7.5	11.5	88.0	4.0	5.0	9.0	8.5	198.0
DOD lab or DOD FFRDC[c]	-	5.5	1.0	4.0	2.0	26.5	8.5	7.0	5.5	1.0	61.0
Industry	-	2.0	-	1.5	3.5	11.0	1.0	1.0	0.5	3.5	22.0
Other	-	5.5	-	-	-	1.0	1.0	-	3.0	0.5	11.0
TOTAL	10.0	50.0	18.5	13.0	17.0	126.5	14.5	13.0	18.0	13.5	294.0

[a] Entries are numbers of papers, as in Table III.1

[b] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

[c] Federally funded research and development center.

TABLE III.5 Distribution of Papers Acknowledging Support by the Atomic Energy Commission[a,b]

Institution Performing Reported Work	AME	EP	NP	P&F	CM	E&P	Opt	Other Phys.	Total
AEC FFRDC[c]	10.5	12.0	38.0	7.5	47.0	1.5	2.0	4.5	123.0
University	7.5	42.0	31.5	7.0	25.5	2.0	1.5	1.5	118.5
Industry	-	-	-	-	2.0	-	-	-	2.0
Other	1.0	-	3.0	0.5	3.0	-	-	-	7.5
TOTAL	19.0	54.0	72.5	15.0	77.5	3.5	3.5	6.0	251.0

[a] Entries are numbers of papers, as in Table III.1.

[b] Subfield abbreviations are the same as those identified in Table III.1, footnote *b*.

[c] Federally funded research and development center.

TABLE III.6 Distribution of Papers Acknowledging Support by the National Aeronautics and Space Administration[a,b]

Institution Performing Reported Work	A&R	AME	EP	NP	P&F	CM	E&P	Acoust	Opt	Other Phys.	Total
University	2.5	11.5	-	0.5	4.0	10.0	18.0	1.0	4.5	3.0	55.0
NASA lab or NASA FFRDC[c]	2.0	7.0	1.0	0.5	2.0	3.0	5.5	-	1.0	3.5	25.5
Industry	-	1.0	-	1.0	0.5	0.5	4.0	1.0	-	-	8.0
Other	-	0.5	-	-	-	1.0	-	-	1.5	-	3.0
TOTAL	4.5	20.0	1.0	2.0	6.5	14.5	27.5	2.0	7.0	6.5	91.5

[a] Entries are numbers of papers, as in Table III.1.

[b] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

[c] Federally funded research and development center.

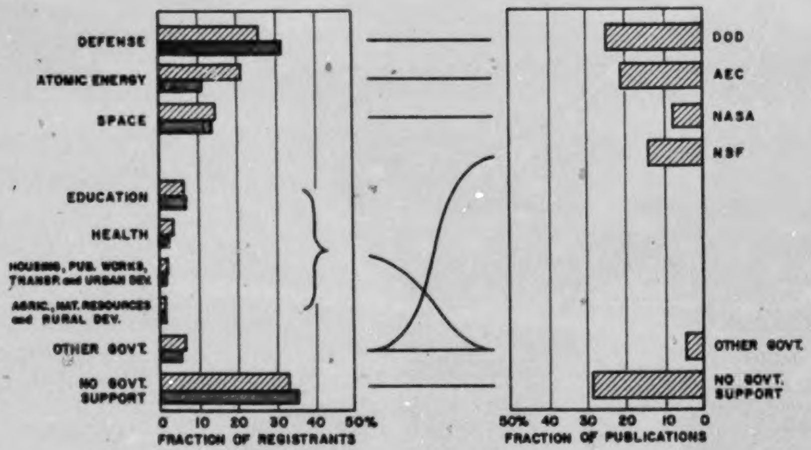

FIGURE III.1 Comparisons of sources of government support reported by respondents to the 1970 National Register (left, shaded bars for PhD's, unshaded for non-PhD's) with those acknowledged in a sampling of 1969 journal articles (right). The lengths of the bars on the left here represent the fractions of those (PhD's or non-PhD's) answering "yes" or "no" to the government support question who mentioned support from the program listed at the left; percentages add to more than 100% because of multiple-support cases. The lengths of the bars on the right, on the other hand, were obtained from the last column of Table III.1 and thus do add to 100%. The lines in the middle column indicate the correspondences between the categories of agencies used in the two studies, which are roughly one-to-one in some cases but are many-to-one in others.

III.1.2.2 *Statements on Government Support by Respondents to the National Register Questionnaire*

One of the questions on the form for the National Register of Scientific and Technical Personnel deals with government support. In 1970 it was worded as follows:

> Is ANY of your work being supported or sponsored by U.S. government funds? [Choices: yes, no, don't know] If yes, is your work related to any of the following programs: [Choices: agriculture, atomic energy, defense, education, health, housing, international, natural resources, public works, rural development, space, transportation, urban development, other program (specify)]

Like the acknowledgments of support discussed previously, these questions yield data on only the number of individuals who indicate that they receive some type of government support; a physicist who receives $500 for summer salary supplementation and one who receives $50,000 for a major research project are equated. Table III.7

shows the distribution of responses to the first part of the question. About 90 percent of the PhD's and 80 percent of the non-PhD's answered with yes or no. The ratio of yes answers to the total respondents declined between 1968 and 1970, for both PhD's (0.67 → 0.60) and non-PhD's (0.59 → 0.52). Thus there seems to have been a decrease during this period in the proportion of physicists receiving federal support.

American Science Manpower presents comparable figures for other fields in 1968. Although 62 percent of physicists, all degrees, received federal support in 1968, only 43 percent of those in all fields included in this publication received such support. The only fields that depended more heavily on federal funds than physics were atmospheric and space sciences (88 percent) and agricultural sciences (70 percent).

TABLE III.7 Government Support by Academic Degree[a]

U.S. Government Support	PhD		Non-PhD	
	Number	Percentage	Number	Percentage
Yes	9,956	59.9	10,188	51.7
No	4,958	29.8	5,626	28.6
Don't know	230	1.4	789	4.0
No answer	1,487	8.9	3,102	15.7
TOTAL	16,631	100.0	19,705	100.0

[a] Data from the 1970 National Register of Scientific and Technical Personnel.

Responses to the second part of the Register question give an indication of the sources of government support in 1970. However, the programs listed are more in the nature of functional fields than either disciplines or activities of specific agencies. For example, it is not clear where a person who had support from the NSF physics program would be able to respond. This ambiguity should be kept in mind in examining the distribution of responses presented in Table III.8. The main findings indicated by this Table are the following:

1. Defense, atomic energy, and space programs provide support for the highest proportion of both PhD's and non-PhD's.
2. A higher proportion of non-PhD's than PhD's receives support from defense activities, and a lower proportion of non-PhD's than PhD's receives support from atomic energy programs. The distribution of support from other government programs is much the same for PhD's and non-PhD's.

TABLE III.8 States Sources of Government Support, by Degree[a]

Source	PhD		Non-PhD	
	Number	Percentage[b]	Number	Percentage[b]
Defense	3,941	39.6	5,023	49.3
Atomic energy	3,235	32.6	1,838	18.0
Space	2,176	21.9	2,215	21.7
Education	1,049	10.5	1,141	11.2
Health	541	5.4	437	4.3
Housing, public works, transportation, and urban development	309	3.2	328	3.2
Agriculture, natural resources, and rural development	262	2.7	293	2.8
Other	1,037	10.4	929	9.1
TOTAL	12,550[c]	-	12,204[c]	-

[a] Data from the 1970 National Register of Scientific and Technical Personnel.

[b] Percent of those with government support (that is, of the 9956 PhD's and 10,188 non-PhD's) who indicate support from a particular program. These percentages do not add to 100 because of multiple responses.

[c] Includes multiple responses. Apparently 2594 PhD's and 2016 non-PhD's indicated more than one source of government support.

Figure III.1 compares the distribution of support among agencies, based on Table III.8, with the distribution of support acknowledged in journal articles (described in Section III.1.2.1). The distributions are similar, with one exception: the other government category for each of the two types of data constitutes a somewhat smaller percentage than one would expect from the presumed correspondence with several categories of the other. The major conclusion from the figure is, however, that the fraction of papers in Tables III.1—III.6 that did not acknowledge any government support probably is about the same as the fraction that, indeed, had no such support.

III.2 Support of Physics Research by Major Government Agencies

That most of the funds for physics research in the United States come from a small number of government agencies made it possible for the Data Panel, in collaboration with liaison representatives of these agencies, to obtain a reasonable picture of the magnitude and distribution of the greater part of these funds. By detailed examination of the records of the agencies, it was possible to obtain dollar amounts for the expenditures on research in each of a number of subfields of physics, using definitions of research and of the boundaries of subfields that would be consistent from agency to agency. This procedure was much more satisfactory for our purposes than simply recording the categories into which the agencies organized their expenditures, as these categories are often not comparable from one agency to another and do not correspond to the subfield division used by the Physics Survey. This detailed survey of the funding of physics research was, however, deficient in a number of respects: Agencies providing only minor support to physics were not included, and even within the major agencies, the activities of some subdivisions were omitted; also, subfields such as physics in biology and earth and planetary physics, in which physics penetrates a large neighboring discipline, were covered only imperfectly. Nevertheless, the tables we will present show a reasonably valid picture of the funding pattern for most of physics.

III.2.1 DETAILED PARTIAL DATA

Table III.9 gives the data obtained from the government agencies that are the chief sources of support for physics research. The definitions of the subfields used were essentially those described in Section IV.1.1. However, there is no miscellaneous category (which accounts for about 4 percent of the U.S. physics literature*); for the entries of this table, all support for miscellaneous physics was assigned to the most nearly appropriate one of the remaining subfield categories, including the interfaces, earth and planetary physics and physics in biology, which are not represented by rows of the table because their funding is inseparable from that of nonphysics disciplines.

Table III.10, similar to Table III.9, shows the distribution of DOD funding among the three major services.

It is interesting to compare these totals (which of course require some supplementation— see Critique of the Data, Section III.2.2) with DOD's breakdown according to discipline.† Apparently most of what DOD classifies as general physics is physics research by our definition; most of what it classifies as nuclear physics is not; significant amounts of what we classify as physics research are found in other of the categories, such as chemistry or materials research.

III.2.2 CRITIQUE OF THE DATA

Our first objective is to make some rough estimates of the magnitude of the expenditures for physics research by agencies or portions of

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Physics in Perspective, Vol. II, Part B, Table XIV.11.

†*Physics in Perspective*, Vol. I, Table 10.A.10.

TABLE III.9 Expenditures by Federal Agencies for Research in the Various Subfields of Physics, 1967—1970[a]

Sub-field[b]	Agency	Dollars per Fiscal Year (in millions)					
		1965	1966	1967	1968	1969	1970
A&R	DOD[c]	2.5	2.8	3.4	2.5	3.1	2.3
	AEC	0.8	0.9	0.9	1.2	1.1	1.3
	NASA[d]	-	-	-	-	-	-
	NSF	-	0.02	0.02	0.02	0.1	0.8
	Total	3.3	3.7	4.3	3.7	4.3	4.4
AME	DOD[c]	4.4	4.4	4.4	3.7	4.8	4.4
	AEC	4.1	4.9	5.1	5.4	5.8	6.1
	NASA[d]	1.9	1.8	1.3	1.4	1.2	1.1
	NSF	1.6	1.0	2.2	2.1	1.7	1.5
	Total	12.0	12.1	13.0	12.6	13.5	13.1
EP	DOD[c]	7.4	7.6	7.3	7.7	2.6	2.3
	AEC	87.2	97.5	107.8	113.4	118.7	120.6
	NASA[d]	0.1	0.1	0.05	0.05	-	-
	NSF	4.4	7.0	9.5	10.5	12.9	12.1
	Total	99.1	112.2	124.6	131.7	134.2	135.0
NP[e]	DOD[c]	9.6	7.9	6.4	4.6	4.9	4.4
	AEC	51.6	61.1	69.7	73.3	77.5	83.8
	NASA[d]	0.5	0.6	0.8	1.4	1.4	1.2
	NSF	4.9	12.3	12.2	15.4	16.4	10.0
	Total	66.6	81.9	89.1	94.7	100.2	99.4
P&F	DOD[c]	3.6	4.0	3.9	4.4	4.2	4.3
	AEC	8.5	9.2	9.7	11.0	11.5	11.8
	NASA[d]	5.6	5.7	5.4	5.0	3.5	2.4
	NSF[f]	-	0.1	0.2	0.3	0.7	1.0
	Total	17.7	19.0	19.2	20.7	19.9	19.5
CM	DOD[c,g]	16.8	17.5	16.9	16.4	18.6	17.0
	AEC	21.9	24.6	26.5	28.3	29.4	29.9
	NASA[d]	2.8	3.8	3.5	4.1	3.3	3.4
	NSF	4.0	5.4	5.6	5.8	6.0	6.1
	Total	45.5	51.3	52.5	54.6	57.3	56.4
Opt	DOD[c]	3.1	2.9	3.3	3.7	3.8	3.5
	AEC	1.0	1.3	1.7	1.4	1.7	1.9
	NASA[d]	0.4	0.7	0.9	1.3	1.4	1.3
	NSF	-	-	-	-	-	-
	Total	4.5	4.9	5.9	6.4	6.9	6.7
Acoust	DOD[c]	0.6	0.8	0.8	0.8	1.8	1.4
	AEC	-	-	-	-	-	-
	NASA[d]	0.05	0.05	0.07	0.03	0.02	0.02
	NSF	-	0.03	0.01	0.01	0.01	0.01
	Total	[illegible]	0.9	0.9	0.8	1.8	1.4

TABLE III.9 Expenditures by Federal Agencies for Research in the Various Subfields of Physics, 1967—1970[a] (continued)

Sub-field[b]	Agency	Dollars per Fiscal Year (in millions)					
		1965	1966	1967	1968	1969	1970
All sub-fields	DOD[c]	48.0	47.9	46.4	43.8	43.8	39.6
	AEC	175.1	199.5	221.4	234.0	245.7	255.4
	NASA[d]	11.4	12.8	12.0	13.3	10.8	9.4
	NSF	14.9	25.8	29.7	34.1	37.8	31.5
	Total	249.4	286.0	309.5	325.2	338.1	335.9

[a] The interfaces, earth and planetary physics and physics in biology, are omitted from this table, because their funding is difficult to separate from that of the relevant nonphysics disciplines.

[b] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

[c] Data from the fiscal supplement 6.1, "Defense Research Sciences" only; see "Critique of the Data" (Section 2.2) for rough estimates of the expenditures under element 6.2, Exploratory Development. Also, only funding by the three services has been included (see Table III.10); see Section III.2.2.

[d] Data for activities of the Office of Advanced Research and Technology only; see Critique of the Data, Section III.2.2 for rough estimates of expenditures by the Office of Space Sciences and Applications and other NASA subagencies.

[e] Data gathered separately and in somewhat greater detail than for the other subfields: See Volume II, Part A, Chapter II, especially Tables II.9 and II.10. Both operations and construction of facilities are included; they are listed separately in the tables cited. The figures refer to basic research only and thus may fail to include some work that would qualify as research under the definition used elsewhere in the table.

[f] Entries undoubtedly too low: See Section III.2.2.5.

[g] Support from the Advanced Research Projects Agency through interdisciplinary materials research laboratories is not included on this line: See Critique of the Data, Section III.2.2 and Table III.11.

agencies not included in the preceding tables. One of the most useful sources of information for this purpose is the acknowledgment of research support in journal articles, the general pattern of which has already been discussed. We have supplemented this general study with some special samples of papers acknowledging DOD or NASA support.

TABLE III.10 Expenditures by the Three Services of the Department of Defense[a] for Research in the Various Subfields of Physics, 1964—1970, with Estimates for 1971[b]

Subfield[c]	Service	Dollars per Fiscal Year (in millions)							
		1964	1965	1966	1967	1968	1969	1970	1971
A&R	Army	0.02	0.03	0.02	0.01	0	0	0	(0)
	Navy	1.1	1.1	1.5	2.0	1.2	1.6	1.2	(0.5)
	Air Force	1.3	1.4	1.3	1.4	1.3	1.5	1.1	(0)
AME	Army	0.3	0.6	0.7	0.5	0.5	0.4	0.6	(0.5)
	Navy	0.4	0.4	0.4	0.6	0.4	0.6	0.5	(0.6)
	Air Force	3.3	3.3	3.4	3.3	2.7	3.8	3.3	(3.7)
EP	Army	0.02	0.05	0.04	0.03	0.07	0	0	(0)
	Navy	6.3	6.3	6.2	6.1	6.5	1.3	1.4	(1.6)
	Air Force	1.0	1.0	1.3	1.1	1.1	1.3	0.8	(0.3)
NP[d]	Army	0.2	0.4	0.4	0.4	0.5	0.3	0.3	(0.4)
	Navy	6.6	6.8	6.8	7.4	6.1	4.0	3.9	(3.3)
	Air Force	0.7	0.7	0.7	0.7	0.7	0.7	0.6	(0)
P&F	Army	0.4	0.5	0.5	0.5	0.5	0.3	0.3	(0.4)
	Navy	0.8	0.8	0.9	0.9	2.0	1.7	1.7	(3.1)
	Air Force	2.2	2.3	2.6	2.5	2.2	2.2	2.3	(1.9)
CM	Army	3.7	3.7	3.9	3.9	3.2	3.9	3.7	(3.8)
	Navy	1.7	1.7	1.7	1.9	2.7	4.4	3.4	(3.7)
	Air Force	11.0	11.4	11.9	11.0	10.5	10.4	10.0	(9.2)
Opt	Army	0.5	0.6	0.5	0.4	0.6	0.7	0.5	(0.6)
	Navy	0.6	0.5	0.5	0.9	1.3	1.5	1.5	(1.5)
	Air Force	1.9	2.0	2.0	1.9	1.9	1.6	1.5	(1.2)
Acoust	Army	0	0	0.02	0.02	0	0	0.05	(0.02)
	Navy	0.6	0.6	0.8	0.8	0.8	1.8	1.3	(0.3)
	Air Force	0	0	0	0	0	0	0	(0)

[a] Data from the fiscal supplement 6.1, "Defense Research Sciences" only; see Critique of the Data, Section III.2.2 for rough estimates of the expenditures under element 6.2 "Exploratory Development." Also, only funding by the three services has been included (see Table III.10); see Section III.2.2.

[b] As in Table III.9, the interfaces, earth and planetary physics and physics in biology, are omitted.

[c] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

[d] Totals in this row do not quite agree with Table III.9, for the data were compiled differently and, in particular, may reflect different assignments of long-term expenditures to years.

III.2.2.1 *Miscellaneous Defense Agencies in DOD*

In regard to support for physics research, the most important of the DOD agencies other than the three services has been the Advanced Research Projects Agency (ARPA). During the 1960's, ARPA provided large-scale support for the creation and operation of interdisciplinary materials research laboratories at some dozen universities. The sums disbursed by ARPA for this purpose are shown in the top line of Table III.11.

TABLE III.11 Support of Interdisciplinary Materials Research Laboratories by the Advanced Research Projects Agency

Activity	Support (in millions of dollars) per Fiscal Year							
	1964	1965	1966	1967	1968	1969	1970	1971
Interdisciplinary materials research laboratories[a]	16.2	17.5	17.7	16.7	1.4	9.6	5.9	4.0
Physics[b]	10.2	11.0	11.2	10.5	0.9	6.0	3.7	2.9

[a] Support provided by the Advanced Research Projects Agency of the Department of Defense.

[b] Rough estimates of approximate amount allocable to physics (0.63 × the support received by interdisciplinary materials research laboratories from the Advanced Research Projects Agency).

A sizable part of this support went for buildings and central facilities usable by workers in several disciplines, so it is less easy to estimate the amount allocable to physics than it is for individual-grant support. A sampling of records of 5 of the 12 laboratories showed a fraction 0.30 of the participating faculty members to be in physics or applied physics departments. However, much physics work in the laboratories is done by faculty of other departments (especially electrical engineering and metallurgy or materials science). A better indication of the distribution of effort among disciplines is provided by counts of publications. We have examined over 600 papers from four of the laboratories and find that about 63 percent of them can be classified as physics, largely condensed matter but with a sizable component also in atomic, molecular, and electron physics. Of the laboratories not surveyed in this count, some are known to have slightly more emphasis on physics than those surveyed, some slightly less. It seems reasonable to make a rough estimate of ARPA support of physics research in the interdisciplinary laboratories by multiplying the top row of Table III.11 by the factor 0.63; the results are shown in the bottom row. This augmentation of the amount spent for condensed-matter and atomic, molecular, and electron physics by the three services (Table III.9) is considerable; it was relatively largest in the years prior to 1967, when the laboratories were in the growing phase.

The ARPA has also spent smaller sums in other types of support of physics research, as have several other defense agencies in addition to the three services. To obtain information on the distribution of DOD support within its subagencies, we sampled all papers in a one-month period in all primary journals published by the AIP. In this sample there were 129 papers from U.S. institutions acknowledging DOD support. The distribution of these among performing institutions and supporting subagencies appears in Table III.12. When allowance is made for the exclusions in the present sample and for the less complete range of journals covered, the distribution over institutions is reasonably consistent with that in Table III.4 and the distribution of papers among the three services is reasonably similar to the distribution of funds displayed in Table III.10. Thus it is logical to assume that, except for the broad institutional grants not reflected in the table and the ARPA support of materials laboratories, DOD support of physics research through other defense agencies has been slightly less than one tenth of that provided by the three services listed in Table III.10.

III.2.2.2 *Physics Research Support under DOD's Fiscal Category 6.2*

Category 6.2, Exploratory Development, involves expenditures two to three times larger than category 6.1, Defense Research Sciences. If even a small fraction of 6.2 is physics research by our definition, it may significantly augment the total from category 6.1, which we have presented in Tables III.9 and III.10. With the cooperation of the Air Force Office of Scientific Research, we were able to trace the fiscal categories under which the 70 papers of our sample reporting Air Force support were funded. (The figure, 70, is greater than the Air Force total in Table III.12 because of a number of cases in which multiple support was acknowledged.) The distribution of these 70 papers is shown in Table III.13.

If these figures can be regarded as typical, it would be reasonable to augment the DOD totals in Tables III.9 and III.10 by about 20 percent to allow for the support of physics research, as we have defined it, through funds in category 6.2. The total augmentation from this source and that discussed in the previous paragraph would be about 25 percent to 30 percent.

III.2.2.3 *Other NASA Support for Physics*

The picture of NASA's support for physics research can vary enormously depending on where the boundaries of physics are placed. Satellite-based lunar and space physics research, although within the scope of the Physics Survey Committee, is often difficult to separate from astronomical and earth-science research, and sometimes even from nonresearch activities conducted simultaneously; in any event, it is exceedingly expensive. As these extraterres-

TABLE III.12 Distribution among Performing Institutions and Sources of Support of a Sample of U.S. Papers Acknowledging Support from the Department of Defense[a]

Performing Institutions and Sources of Support	Papers	
	Number	Percent ($N = 129$)
Performing Institution		
University	99	77
Industry	21	16
Government (non-DOD) laboratory	1	1
Other (including federally funded research and development centers)	8	6
Source of Support within DOD		
Army		
ARO Durham[b]	17.5	14
Other	7.5	6
Navy		
ONR[c]	24	19
Other	4	3
Air Force		
AFOSR[d]	48	37
Other	19.5	15
Other defense agencies	8.5	7

[a] When more than one DOD subagency was acknowledged, or when two collaborating performers each acknowledged DOD support, fractional weights were assigned. Work at DOD-operated laboratories or other agencies receiving DOD funds is included, as is that of all federally funded research and development centers. Support from the Advanced Research Projects Agency is included only when specifically related to the research report (not merely support of interdisciplinary materials research laboratories).

[b] Army Office of Research at Durham, North Carolina.

[c] Office of Naval Research.

[d] Air Force Office of Scientific Research.

TABLE III.13 Categories under Which Support Was Granted for Work Reported in 70 Physics Research Papers Acknowledging Funds from the Air Force

DOD Category	Number of Papers	
Defense research sciences (6.1)	58	
General physics, nuclear		34
physics, and astronomy and astrophysics		0
Other categories (chemistry, electronics, etc.)		24
Exploratory development (6.2)	12	

trial programs have been discussed at length elsewhere,*,† we shall try merely to develop a rough picture of the extent of NASA funding of laboratory, theoretical, and terrestrial field work. We shall not discuss the last of these in any detail; it will suffice to remark that in a sampling of papers appearing in journals in the earth sciences the content of which is largely physics, we found the sources of support acknowledged to be distributed among a wide variety of agencies, with DOD and NSF each acknowledged considerably more often than NASA; for extraterrestrial research the proportions were reversed.

Of greater concern is the distribution of support for the core subfields of physics among the different branches of NASA. This agency's report on its university program* provides a helpful guide, since, according to Table III.6, of 59.5 NASA-supported papers in subfields other than astrophysics and relativity and earth and planetary physics, 34.5, or 58 percent, were from universities. A perusal of this document shows that about 94 of the 172 items classified by NASA as physics were operating under a current grant or contract in September 1969. However, only about 79 of these were in the core subfields of physics. Some approximate figures for the annual rate of funding reported there appear in Table III.14. Here, the category "Other NASA" represents for the most part funding through the various NASA in-house laboratories; the funds in general came from the Office of Advanced Research and Technology or the Office of Space Science Applications but in proportions that are not revealed in the data. The figures of Table III.14 need to be supplemented by estimates of physics work appearing in the listings under other classifications than physics. A sampling of the listings has convinced us that the amount of such university work in the physics subfields covered by Table III.14 was rather less than the amount given in the Table, though quite possibly over half as great. Thus, the total FY 1970 NASA support for university work in these subfields was doubtless in the range of $3 million to $4 million, and probably closer to the lower figure.

**NASA's University Program* (Office of University Affairs, NASA, 1970). Mispagination made our survey incomplete, hence our use of the words "about" and "approximate" in the text.

†*Physics in Perspective,* Vol. II, Part B, Chapter IX.

TABLE III.14 Approximate Distribution among Subfields of Support from the National Aeronautics and Space Administration in 1969 (FY 1970) for Physics Research [a] in Universities

Physics Subfield	NASA Funding (FY 1970) (in millions of dollars)		
	OART [b]	OSSA [c]	Other NASA
Atomic, molecular, and electron	0.27	0.19	0.19
Plasmas and fluids	0.43	0.10	0.34
Condensed-matter	0.07	0.13	0.18
Other subfields [d]	0.15	0	0.05
TOTAL	0.92	0.32	0.76

[a] Research classified by NASA as physics.

[b] Office of Advanced Research and Technology.

[c] Office of Space Science Applications.

[d] Not including earth and planetary physics, astrophysics and relativity, and physics in biology.

A tempting procedure for estimating the amount of NASA support through divisions other than the Office of Advanced Research and Technology (essentially the Office of Space Science Applications) for the core subfields represented in Table III.14 is the following: Combine the estimate just given for total NASA support of work in these subfields in universities with the assumption that the ratio of support for nonuniversity work (for example, in industry or in-house laboratories) to that for university work is the same as the ratio of numbers of publications as given in Table III.6. Unfortunately, this assumption does not always seem to be a reasonable one: Well over half of the NASA-supported papers in this table are from universities, yet even our highest estimate for the dollar amount of support of such work is less than half of the amount recorded in Table III.9 for support by the Office of Advanced Research and Technology alone. Examination of particular subfields reveals that this discrepancy is not present for atomic, molecular, and electron physics but is pronounced for plasmas and fluids and condensed-matter, as well as for the sum of the remaining core subfields. In general, we can write, using an obvious notation for different components of expenditure F,

$$\begin{aligned} F_{\text{NASA}} &= F_{\text{OART}} + F_{\text{Other}} \\ &= F_U + F_{\text{non-U}} \\ &= F_U\left(1 + \frac{25}{34.5}\, r\right) \qquad (1) \end{aligned}$$

where the first line represents the division between sources of funding within NASA, the second line the division between performers receiving the funds, and, in the third line, the ratio 25/34.5 is the ratio of papers sampled from nonuniversity to university performers in Table III.6, and r is the ratio of cost to NASA per nonuniversity paper supported to cost per university paper supported. (As in Table III.14, we are excluding the important interfaces, earth and planetary physics, astrophysics and relativity, and physics in biology.) Even with what would seem to be the quite extreme assumptions F_U = \$4 million, $r = 3$, Equation (1) still gives for F_{Other} only a minor fraction of F_{OART}.

Since NASA does not contribute much of the support for the most expensive types of research in elementary-particle, nuclear, and plasma physics (although it does support some research on plasmas), it is not unreasonable to make a rough estimate of the total amount of NASA support for research in the core subfields from the counts of papers in Table III.1. Such an estimate gives, for example, a NASA activity equal to about 39 percent of that of the NSF. This estimate again would be consistent with augmenting the NASA figure given in Table III.9 by no more than about one third. Thus we believe that a minor augmentation of this order is the appropriate one for the core subfields. The large expenditures that NASA certainly makes in physics-related fields are undoubtedly concentrated in the astronomical and earth and planetary subfields.

Before concluding this section we should comment on the unusually wide range of numbers that one can obtain for NASA support of research by consulting different sources. For example, the figures reported in the NSF's *Federal Funds for Research, Development, and Other Scientific Activities* show some \$90 million for basic research in elementary-particle physics, whereas one almost never encounters an elementary-particle physics paper with an acknowledgment to NASA. Apparently a different definition is being used. The same NSF publication reports nearly \$60 million of NASA funds for basic research in universities, and a comparable figure for applied research and development in universities, whereas the grants and contracts listed in *NASA's University Program* as active in any given year add to a much smaller figure. Clearly, definitions of what is included are critical in interpreting dollar figures. We believe that the figures we have developed here, although only approximate, are reasonably correct for NASA's support of publishable physics research in the core subfields.

III.2.2.4 *Other Federal Agencies*

According to Table III.1, the number of physics papers citing support from federal agencies other than DOD, AEC, NASA, and NSF is a fraction about 0.067 of the number citing support from these agencies; if we restrict ourselves to the core subfields (excluding astrophysics and relativity, physics in biology, and earth and planetary physics) the fraction is 0.077. Undoubtedly, the agency responsible for most of this other government support is the National Bureau of Standards; however, occasional support from the Department of Health, Education and Welfare (especially in physics in biology) and from other agencies is encountered. Table III.15 shows the distribution of support by the National Bureau of Standards in FY 1970. Figures for the Office of Standard Reference Data are separated from the others; although for the most part this work is not the generation of entirely new knowledge, it represents a consolidation of knowledge that is vital for the progress of research effort and provides an example that other research-supporting agencies would do well to emulate.

TABLE III.15 Amounts Expended by the National Bureau of Standards for the Support of Physics Research and Consolidation of Research Results, FY 1970

Physics Subfield	Research Units	OSRD[a]	Total
Astrophysics and relativity	0	0	0
Atomic, molecular, and electron	2.53	0.55	3.08
Elementary-particle	0.43	0.02	0.45
Nuclear	1.42	0.04	1.46
Plasmas and fluids	1.08	0	1.08
Condensed-matter	2.80	0.40	3.20
Earth and planetary	0.30	0	0.30
Physics in biology	0.05	0	0.05
Optics	0.74	0	0.74
Acoustics	0.33	0	0.33
Miscellaneous physics	0.72	0.15	0.87
TOTAL	10.39	1.16	11.55

[a] Office of Standard Reference Data.

III.2.2.5 *Consistency of the Funding Picture*

It has become clear in the course of this discussion that one can get wildly different numbers for the funding of research in any subfield of physics, depending on the definitions one uses of research and of the scope of the various subfields. Our philosophy has been to identify funding levels for research, be it basic or applied, defined as the production of new knowledge that becomes part of the generally accessible public record and to delimit physics from other disciplines and the subfields from one another by judgments that will be consistent with the pattern of citations in the research literature (see Section IV.1.1). Thus one should be able to compare the funding figures that we have developed with the acknowledgments of research support found in a random sample of papers in the literature, as given in Table III.1. One does not expect proportionality of dollars with acknowledgments: Some subfields are much more expensive than others; some agencies concentrate on the support of expensive subfields or the support of expensive facilities in these subfields; with some subfields or agencies, support may tend to be more nearly total than in others. But one would like to feel that any differences in the patterns of dollar support and acknowledgments are reasonable, with allowance for known effects of these kinds.

Figure III.2 shows this comparison. In regard to the distribution among agencies, shown at the top of the figure, the comparison is quite reasonable: The vastly larger relative dollar expenditures by the AEC are understandable in view of the great expense of the large machines used in elementary-particle and nuclear physics and to some extent also in plasma physics; these are supported almost entirely by AEC. The same factors account for the anomalies in the distribution over subfields, shown at the bottom of the figure.

A detailed breakdown by both agency and subfield is hardly worth making, as the entries in Table III.1 suffer from small-number statistics. However, examination of the entries does reveal at least one shortcoming in the funding figures of Table III.9: The figures for funding of research in plasma physics and the physics of fluids by the NSF are undoubtedly too small. Apparently a considerable amount of work supported as engineering, mathematics, or some other nonphysics discipline actually appears in the physics literature as physics.

III.3 Industrial Support of Physics Research

The fairly large contribution of industrial organizations to the support of physics research in the United States, although almost entirely localized in their laboratories, is not easy to isolate, because the same organizational units often perform not only research but development and other activities. Therefore, we decided to investigate this support by requesting relatively detailed information from a small but representative group of industrial laboratories. As a by-product, useful data relevant to other portions of this report were obtained; these will also be presented and cross-referenced from the appropriate other sections.

III.3.1. RATIONALE OF THE SAMPLING APPROACH

Because we are interested in the support of research, defined as the production of published new knowledge, we undertook first to find out how the volume of publication in physics journals is distributed among U.S. industrial laboratories. By counting publications in physics journals listed in the Corporate Index section of the 1969 *Science Citation Index*, we identified about 40 laboratories with high publication rates in physics. The leading 25 of these are listed in Table 9.3 of Volume I of *Physics in Perspective*. The extent to which U.S. industrial research is concentrated in these leading companies can be ascertained by comparing the total of their publications with the total published from all U.S. industrial sources. One can do this crudely by comparing the total

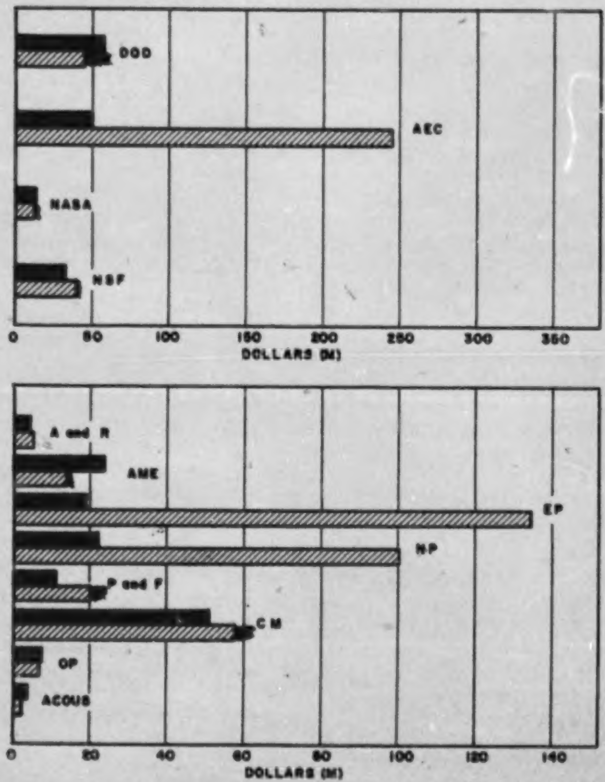

FIGURE III.2 Comparison of estimated dollar distribution of federal funding with counts of physics papers acknowledging federal support. Shaded bars are totals for FY 1969 from Table III.9, terminated in some cases by regions of opposite shading to take account of augmentation estimates in Section III.2.2. Open bars (arbitrary scale) are proportional to number of acknowledgments in Table III.1. Top: distribution over major agencies, work in all subfields exclusive of earth and planetary physics and physics in biology. Bottom: distribution over subfields for work funded by the four major agencies. Note differing scales of dollars.

of 2179 papers from the 25 companies in Table 9.3 with the total estimated physics papers from all U.S. industrial organizations, 2900, given in Table XIV.11 of Volume II, Part B of *Physics in Perspective*. The ratio of these two numbers is 0.75; however, one might doubt the validity of this comparison, since one group of papers represented publications in any kind of journals deemed to be physics journals and the other represented research articles in physics appearing in any publication covered by *Physics Abstracts*. However, the ratio is remarkably close to that obtained in an independent sampling of articles in some 16 journals in which 216 articles from these 25 companies were found compared with a total of 293 from all industrial organizations. The ratio of these two numbers is 0.74. Thus it is fairly safe to conclude that a sample drawn properly from these 25 organizations and others of only slightly lower productivity should be adequate to characterize physics research in U.S. industry as a whole.

A representative sample from industry should have two characteristics: It should contain proper representation from both large and small laboratories, and it should take into account the different research patterns typifying different types of industries (electronic, aerospace, chemical, and the like). We sought detailed information from 21 companies, fairly evenly distributed among six types of industry shown in the tables that follow. Confidentiality of replies was promised, and usable data were received from 18 of the 21.

To make it as convenient as possible for our respondents to give answers that would have a relatively clearly defined meaning, we requested data from only a single organizational subunit of each company, generally the one with the greatest research activity in physics. For each subunit we requested the following information:

1. Staff: total professional staff; number working as physicists; physics and nonphysics doctorates; theoretical physicists.
2. Costs: total cost for all work done by the research unit; relative cost per professional for physics and nonphysics work; fraction of costs paid by company, government, and other sources.
3. Publications: fractions of work appearing in publications, patents, under security classification, or for internal use only; number of published papers in all fields; number published in AIP journals.
4. Time trends: changes since two, five, and ten years ago in physics manpower, cost per professional per year; expected changes in manpower in the next two or five years.

Our respondents were asked to select the administrative subunit on which to report in such a way that its characteristics would typify the greater part of the physics research done by the company.

III.3.2 RAW DATA

Table III.16 shows the staff composition of the organizational units sampled. The reader must be cautioned against drawing infer-

TABLE III.16 Manpower Data from 18 Industrial Research Organizations (1970)

Types of Data Supplied	Types of Industry						
	Communication and Electronic Data Proc.	Other Electronic	Optical or Other Instrumentation	Aircraft and Space	Chem. and Metallurg.	Misc. Mfg.	Total Units Sampled
No. of companies sampled	4	4	2	3	3	2	18
Total tech. staff professionals in units sampled	882	928	50	358	597	578	3375
Doctorates on tech. prof. staff	627	462	21	192	364	260	1926
Fraction	0.71	0.47	0.42	0.54	0.63	0.45	0.57
Range	0.67–0.97	0.40–0.94	0.36–0.48	0.45–0.76	0.48–0.77	0.37–0.54	
Physicists in units sampled	302	255	30	275	65	126	1053
Fraction	0.34	0.28	0.60	0.77	0.11	0.22	0.31
Range	0.20–0.90	0.17–0.81	0.60–0.60	0.56–1.0	0.06–0.13	0.20–0.23	
PhD physicists	272	194	16	150	47	76	755
Fraction	0.90	0.76	0.53	0.55	0.72	0.60	0.72
Range	0.70–0.90	0.63–1.0	0.47–0.60	0.46–0.76	0.46–0.87	0.51–0.71	
Theoret. physicists	52	19	0	55	7	8	141
Fractional growth total phys. staff[a]							
Since 1960	0.30±0.02	0.23±0.70	-	-	0.40±0.85	0.55±0.20	-
Since 1965	-0.08±0.04	-0.15±0.10	0.40±0.10	0±0.30	0±0.10	0.20±0.05	-0.02
Since 1966	-0.01±0.07	-0.14±0.05	-0.05±0.15	-0.25±0.05	-0.05±0.07	-0.02±0.07	-0.11
Est. by 1975	0.02±0.05	-0.09±0.11	0.15±0.15	0.05±0.05	0.10±0.05	0.05±0.05	0.014

[a] Averages weighting each organization's percentage by the size of staff involved. Numbers following ± are standard deviations for the group.

ences about the total research staffs of the various types of industries from the data shown. Each company supplied data only for a certain organizational subunit, so chosen that its work in physics could be considered typical of that of the company as a whole but by no means necessarily having the same proportion of physicists and nonphysicists as would obtain for those engaged in research throughout the company. Caution also is necessary in regard to other characteristics of the sample. For example, that the ratio of physicists to total staff is smaller for the chemical and metallurgical and miscellaneous manufacturing categories than for the others may well result from the obviously lesser physics orientation of the research programs of these types of companies. Because of this lesser orientation toward physics, they are less likely to have an organizational subunit with a high proportion of physicists.

The proportion of theoretical physicists is highest in the communication and electronic data-processing, aircraft and space, and chemical and metallurgical industries and is low elsewhere. This circumstance undoubtedly affects the relative cost of physics research.

The final rows of the table show a fairly consistent picture of growth during the early 1960's, retrenchment at the end of the 1960's and anticipated modest growth in the 1970's. As might be expected, there are substantial fluctuations from company to company within each group. Not surprisingly, the most violent fluctuation has occurred in the aircraft and space companies.

Table III.17 gives a similar presentation of data on the cost

TABLE III.17 Funding Data from 18 Industrial Research Organizations (1970)

	Type of Industry					
Types of Data Supplied	Communication and Electronic Data Proc.	Other Electronic	Optical and Other Instrumentation	Aircraft and Space	Chem. and Metallurg.	Misc. Mfg.
Cost of work ($K) per professional per year	65	67	65	51	49	62
Range	51–80	53–94	60–70	35–75	50–70	45–76
Approx. physicist cost/mean cost	1.00	1.05	1.05	1.00	0.93	0.90
Average fractional increase in cost/professional						
Since 1960	0.60	0.56	-	0.45	0.50	0.55
Since 1965	0.18	0.23	0.30	0.27	0.35	0.23
Since 1968	0.13	0.08	0.10	0.15	0.30	-
Average fraction of costs supported by						
Own company	0.98	0.85	0.44	0.28	1.00	1.00
Government	0.02	0.15	0.56	0.72	0	0

of research and other work performed by the units sampled. Although there is again some fluctuation from organization to organization within each group, the average cost of work per professional staff member is remarkably constant among groups. Also, the cost per staff member for work in physics is always considered as close to the average of all work done by the organizations. The middle lines of the table indicate a fairly steady increase in the cost of research during the past decade, at a rate of about 4.5 percent per year.

The last two rows of the table are significant, for any estimate of the contribution from private enterprise to the support of physics research must take into account that an appreciable fraction of the work done in industrial laboratories is supported not by the companies concerned but by the government. This proportion is particularly high in the instrumentation and aircraft and space categories. However, some companies in other categories operate completely federally funded research and development centers; these are excluded from both our present sampling and the analysis that follows.

Table III.18 presents statistics on research publications by the units sampled. The ratio of papers appearing in AIP journals to the total is a rough, though by no means infallible, measure of the degree of emphasis on physics in these organizations. The ratios correlate generally with the fraction of staff who are physicists, shown in Table III.16. The chemical and metallurgical and miscellaneous manufacturing categories have the lowest figures. The miscellaneous category also has a rather low fraction of its physics research appearing in published form; however, this finding may be an artifact of the choice of organizational subunits. The amount of work eventuating in patents seems to be particularly high in the optical and instrumentation category, and the chemical and metallurgical laboratories have a substantial number of doctoral-level staff members who publish little.

III.3.3 ANALYSIS AND INFERENCES REGARDING INDUSTRIAL FUNDING

Our procedure for estimating the amount of support contributed by U.S. industry to research in physics will be, in essence, to find the expenditure for such research by the organizational units of the sample and to multiply this by the ratio of the total amount of U.S. industrial physics research to that performed by the organizations sampled. We shall try to do this in as thorough a manner as possible, taking account of possible differences in the research patterns of different types of companies. We should point out, however, that our sample is not only fairly representative of the distribution of physics research over different types of companies but even constitutes a large fraction of the total population we wish to consider, in that the organizations sampled contribute nearly one third of all the physics publications from U.S. industrial laboratories, and the total output from the companies in which these suborganizations reside is about two-thirds of the national total. Consequently, our extrapolation will not have to be by a large factor.

TABLE III.18 Publications by Industrial Research Organizations in a One-Year Period (1969–1970)

Types of Data Supplied	Type of Industry Communication and Electronic Data Proc.	Other Electronic	Optical or Other Instrumentation	Aircraft and Space	Chem. and Metallurg.	Misc. Mfg.	Total Units Sampled
No. of companies sampled	4	4	2	3	3	2	18
Total papers published by units sampled	705	425	37	195	157	240	1759
No. of papers in AIP journals	288	161	19	71	22	53	614
Average fraction of physics work[a]:							
Published	0.89±0.05	0.72±0.13	0.70±0.10	0.80	0.68±0.28	0.42±0.30	≈0.75
Appearing as patents	0.09±0.06	0.23±0.05	0.13±0.08	0.04±0.03	0.02±0.02	0.08	-
For internal or classified use only	0.02±0.05	0.05±0.05	0.17±0.02	0.16±0.02	0.30±0.30	0.50±0.35	-
Publications per PhD staff member[a]	1.00±0.65	0.87±0.30	2.00±1.20	1.15±0.10	0,41±0.10	0.92±0.08	0.91

[a] Averages weighting each organization proportionally to its size. Numbers after ± are standard deviations for each group.

An essential ingredient of the extrapolation to national totals is a knowledge of the ratio of physics research publication by the units sampled to that from all U.S. industrial organizations. We shall assume that this ratio is given by the ratio of numbers of research papers in AIP journals. The entries in the third column of Table III.18 give the number of such papers for each category of the organizations sampled. Respondents were instructed to include only research papers and letters, not abstracts. For comparison, we have sampled all AIP research journals, the more important ones for a two-month period, others for a one-month period, and have recorded the number of articles of which the first-named author was attached to an industrial research organization. The resulting figures extrapolate to a yearly total of about 1470 papers. This figure should have a sampling probable error of the order of 5 percent.

The figures in Table III.18 require a slight correction before they can be compared with the one just derived. In the estimated yearly total, 1470, each paper is counted but once; each was assigned to the institution of the first-named author, or, equivalently, each sponsoring institution was assigned a fractional weight when there was collaboration between institutions. The figures in Table III.18 undoubtedly have no such fractional weighting for collaborative efforts. A rough sampling of papers suggests that the correction for this effect should amount to about 10 percent. Accordingly, we estimate that the fraction of the U.S. industrial research effort in physics accounted for by our sample is approximately

$$\text{Fraction} = \frac{614}{1.1 \times 1470} = 0.38. \tag{2}$$

To estimate the distribution of physics publishing activity among the types of industrial organizations, we again made use of the sample of AIP journals mentioned previously, developing a general classification of each performing institution into one of the six categories used in the preceding tables or, occasionally, relegating it to an unclassified or unknown category. The results appear in the first column of Table III.19. If, for want of better information, we assume that the few companies in the other or unknown category resemble the weighted average of the others in such respects as fraction of physics work supported by government and fraction published, we can infer a set of weights with which the six categories we sampled should be combined to give a reasonable national average. These weights are shown in the second column of Table III.19; merely for comparison, we show in the penultimate column, in parentheses, the distribution of papers in AIP journals from the units in our sample, that is, the ratios of the third line of Table III.18 to the total in the final column. The general resemblance of these to the numbers in the column showing weight factors justifies the statement that our sample is fairly representative of the distribution of physics research among different types of companies.

TABLE III.19 Contributions of Different Types of Industries to Physics Publication and Support of Published Research

Type of Industry	Papers in an AIP Journal Sample	Weight Factor Adopted	Fraction of AIP Papers in Sampled Organizations	$Million Contribution to Funding from Resources of Sampled Organizations [Eq. (2)]
Communication and electronic data processing	104	0.37	(0.47)	16.3
Other electronic	59	0.22	(0.26)	10.9
Optical or other instrumentation	26	0.10	(0.03)	0.6
Aircraft and space	39	0.14	(0.12)	3.2
Chemical and metallurgical	33	0.12	(0.04)	2.0
Misc. manufacturing	10	0.05	(0.09)	3.0
Other or unknown	22	-	-	-
TOTAL	293	1.00	(1.00)	36.0

We shall try to estimate the support of physics research from company funds by first estimating the amount of such support for each category of units in our sample and then combining these with suitable weights. For a crude first approximation, one could ignore the differences between different types of industries and take the expenditure for our whole sample allocable to published research and divide it by the ratio (2). But to get the first of these quantities we must make allowance for all works not being destined for publication and for support of some work from government funds. Thus for any organization or group of organizations we have

$$E = \text{company expenditure allocable to published physics research}$$

$$= c_{\mathrm{ph}} N_{\mathrm{ph}} f_{\mathrm{Pub}} F_{\mathrm{own}}, \qquad (3)$$

where c_{ph} is the cost of work per physicist staff member, that is to say, the product of the two top rows of Table III.17, N_{ph} is the number of physicists, f_{Pub} is the fraction of physics work published, and F_{own} is the fraction of work supported from company funds. In writing this equation we assume that the last fraction is about the same for physics as for other kinds of work of the organizational units sampled. With an average of about $60,000 for c_{ph}, 0.75 for f_{Pub}, and 0.85 for F_{own}, we get about $40 million for the quantity (3) for our entire sample. Dividing by the 0.38

of Eq. (2) gives a roughly estimated national expenditure of \$105 million annually of industrial funds for publishable physics research.

A more refined calculation would evaluate Eq. (2) separately for each category I of organizations in our sample and combine these according to the formula

$$E_{\text{US}} \equiv \begin{array}{l}\text{national expenditure of industrial funds}\\ \text{allocable to published physics research}\end{array}$$

$$= 1.1\, P_{\text{US}}(\text{AIP}) \sum_{I} \omega_I \, \frac{E_I}{P_I(\text{AIP})}\,, \qquad (4)$$

where ω_I is the weight factor given in Table III.19, P_I(AIP) is the number of AIP papers from category I (third row of Table III.18), P_{US}(AIP) = 1470 is the estimate given for the number of papers published annually in AIP journals from U.S. industrial organizations, and the factor 1.1 is the multiple authorship correction we have already used in deriving Eq. (2). The result is close to the rough estimate of the preceding paragraph:

$$E_{\text{US}} = \$98 \text{ million} \qquad (5)$$

for the one-year period, mid-1969 to mid-1970. The E_I values used in this calculation are given in the last column of Table III.19.

III.3.4 CRITICAL COMMENTARY

There are several possibilities for systematic errors in this estimate, though we hope that none are catastrophically large. We have mentioned the assumption that the fraction F_{own} given in Table III.16 is applicable to the physics portion of the work. Another question concerns the assumption that the costs of physics work can be estimated from the top rows of Table III.17 and the fraction of the staff who are identified as working as physicists. As we shall see in Section IV.1.3, many papers whose content is clearly physics are produced by persons who identify primarily with some other discipline. There is a compensating effect in that some of the work published by physicists may pertain to a nonphysics discipline; moreover, that our questionnaire referred to people working as physicists helps to reduce the overlap effect. The alternative assumption that the funds expended by the organizational units sampled were distributed between physics and nonphysics in proportion to the amounts of physics and nonphysics publication undoubtedly greatly overestimates the expenditure on physics. If one assumes the ratio of AIP publications to total publications in physics as about 0.6, this approach would lead to an expenditure on physics about half again as great as that which we have derived. In view of the higher rate of publication in physics than in the more applied disciplines, this discrepancy is by no means unreasonable. Thus we believe that the value given in

Eq. (5), although it may be a slight underestimate, is probably a fairly realistic figure.

The fraction of physics costs supported from government sources is appreciable: The weighted average of the entries in Table III.17 is about 0.15. It is interesting to compare this ratio with the ratio of papers from industrial performers acknowledging government support to those acknowledging no such support. The latter ratio can be obtained from Tables III.1, III.4, III.5, and III.6 and is about 0.19. This amount may be a slight underestimate, for it refers only to the three leading government agencies (that is, leading in the support of physics research). The difference between the two figures is not unreasonable, for government support often is only partial, and the more expensive projects are more likely to be undertaken with such support.

Support of work in industrial laboratories from sources other than the company or the federal government seems to be negligible.

We must reiterate that the organizations surveyed were selected to be representative of the greater portion of physics research in industry leading to publication; they were undoubtedly not typical of the total employment of physicists in industry. As an example of a difference, 72 percent of the physicists in the survey have a PhD degree, but only 39 percent of the physicists employed by industry have a PhD, according to the National Register. Again, the growth of physics staff from 1960–1968 and its recession from 1968–1971, shown for our sample by the entries in the lower rows of Table III.16, differ slightly from the statistics on the nationwide employment of physicists in industry obtained from the National Register*: The PhD's employed in industry, whose number might be expected to correlate with the total staffs of the research-oriented organizations, appear to have increased monotonically, according to the National Register, and more rapidly in the last decade than the figures in Table III.16 indicate.

We have searched for correlations between the answers to various questions by the respondents in our sample. A number of correlations emerge in a least-squares analysis at better than a 95 percent significance level, although their relationship to cause and effect is not always clear:

1. The cost per professional increases appreciably with increasing fraction of the professionals who are PhD's and decreases slightly with increasing size of the organization.
2. The ratio of cost per professional for physics to that for other work is less the higher the fraction of physicists who are theorists; an experimental physicist seems to cost slightly more than an average professional, a theoretical physicist only about 70 percent as much.
3. Physicists seem to be more heavily supported by the government than other professionals and non-PhD physicists much more so.
4. The fraction of physics research published correlates positively with both the fraction of physicists who are PhD's and the

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**American Science Manpower* (National Science Foundation, biennial).

fraction of government-supported research.

5. The total number of publications of an organization (in all fields) correlates strongly with the number of PhD physicists. The number of papers in AIP journals per PhD physicist correlates negatively with the number of non-AIP physicists.

III.4 Physics Research Support from University Funds

III.4.1 INTRODUCTION

Although everyone knows that some portion of the research done in U.S. universities is supported from the resources of the universities, there have been only guesses as to the amount of this support. To obtain a quantitative estimate, the Data Panel sought the cooperation of a number of university physics departments in filling out a rather detailed questionnaire about departmental research activities. As a by-product, some information about purely educational matters was collected also.

Being aware of the excessive demands on university departments for the completion of questionnaires and of the difficulty of getting prompt and uniform responses to questionnaires distributed in an impersonal way, we decided to sample only a small number of institutions in which we had close personal contacts. This procedure led immediately to the problem of taking adequate account of the diversity of types of universities. Probably the most important difference is between the major research institutions and those in which research is less prominent, either in volume or intensity. We distributed our sample over three ranges of size and, within each size range, over two levels of distinction, measured by the often-cited "Cartter ratings."* The following six groupings resulted.

1. A, Faculty size $\geq$ 50, or among the top ten universities in volume of physics publication, Cartter rating "distinguished" or "strong."
2. B, Faculty size $\geq$ 50, Cartter rating not "distinguished" or "strong."
3. C, Faculty size between 30 and 50, Cartter rating "good" or above, not in group A.
4. D, Faculty size between 30 and 50, Cartter rating below "Good."
5. E, Faculty size 30 or below, Cartter rating given.
6. F, Faculty size below 30, no Cartter rating given.

Non-PhD-granting institutions were not sampled, because studies of publication patterns (see Figure III.11) have shown that these account for no more than a few percent of research publication in

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*Cartter, A. *An Assessment of Quality in Graduate Education.* Washington, D.C.: American Council on Education, 1966.

physics (although, curiously, for a somewhat higher fraction of abstracts in the *Bulletin of the American Physical Society*). We requested completion of questionnaires from two institutions of each of the six types, except A, B, and D, from which we sought four, one, and one, respectively, Eight of the 12 were returned. The composition of the sample was as follows: A, 3; B, 1; C, 1; D, 0; E, 2; and F, 1.

The design of the questionnaire reflected our desire to ask for information that would be reasonably easily and unambiguously available in most departmental records and, at the same time, relevant to our concerns. Although we consulted several present or past chairmen of physics departments before crystallizing it, the questionnaire finally adopted achieved these goals only imperfectly. The philosophy was to divide support of research into three categories: first, faculty time (including overhead); second, equipment, nonfaculty staff, and miscellaneous items; and third, space. Although a few institutions keep records of the distribution of faculty time among different kinds of activities, such as teaching and research, most do not; therefore we requested information only on number of faculty at each rank taking part in research, class-contact hours for them, and amount of their time for which outside support was received. By combining these data with information on time actually spent in research from two or three institutions, we hoped to get plausible estimates for the others. University support for equipment and nonfaculty staff we hoped to estimate by ascertaining the difference in total costs for these purposes and support received; unfortunately, incompleteness and ambiguity in the data rendered these sources of information highly questionable. In regard to space, we requested information on the amount of space used for research and on the fraction of building construction costs that came from university funds. Questions also were included on number of publications, changes in costs in the last two years, numbers of graduate and undergraduate students, and instructional effort devoted to nonscience majors, teachers, and others.

The responses were of variable quality, as analyses in subsequent sections will show.

III.4.2 RAW DATA

Table III.20 shows the principal data received from the eight responding physics departments, totaled for the different subfields of physics. The data are not complete; in a few cases appropriate entries have been estimated from other sources and these are identified in the footnotes to the table.

Table III.21 presents the data by subfield and summed over the responding universities. The reader should note that some data are for all eight universities, some for seven, some for only four.

III.4.3 CORRELATIONS IN THE DATA

The contribution of universities to the support of research, our major concern, comes in large part from support of the time faculty members devote to research. Our first task was to estimate this time. Since the productive output for which universities are supported consists almost entirely of research and teaching (with a broad interpretation of both), one should count as time devoted to research not only time spent in the direct performance of research but also an appropriate fraction of time spent on departmental administration, service to the scientific community, and like activities. Unfortunately, most university departments keep no records of how their faculties distribute their time among teaching, research, administration, and other activities. However, in the course of preparing our questionnaire, we learned of a few universities that keep such records and decided to estimate faculty time allocable to

TABLE III.20 Characteristics of Physics Research at Selected Universities

Types of Data Collected	Type of Institution and Institution Number (in parentheses)							
	A (1)	A (2)	A (3)	B (4)	C (5)	E (6)	E (7)	F (8)
Cartter rating[a]	D	S	S	G	G	A	G	-
Faculty in research[b]	97	38	77	50.2	37.7	24	22	16.6
Nonfaculty staff[c]	?	?	100	12	10.5	4	13	3.7
Average class-contact h/wk per faculty in research	6.0[d]	5.4[e]	2.93	2.55	2.64	5.75	2.60	5.18
Publications in year[f]	71	84[g]	117	108	54[h]	40	31	41
No. of publications without outside support	1	-	-	1	-	9	-	-
Support from outside[i] (in $ millions)	-	2.57	5.20	2.64	-	-	0.76	-
Man-months faculty time supported from outside	525	88	251	156	164	60	47.5	13.5
Sq ft used for research[j] (in thousands)	138.5	46.2	116.3	67.0	60.0	12.8	63.0	16.1
Fraction of plant cost from outside		0.14	0.25	0.05	0.35	0	0.375	0
No. undergrad. majors	366	217	60	226	82	90	22	168
No. graduate students	274	171	165	190	123	90	72	72
Fraction of teaching for nonscience majors[k]	0.05	0.2-0.4	0.15	0.23	0.35	-	0.15	0.20
Overhead factor[l]	0.54	0.47[m]	0.45	0.57	0.46	~0.70[n]	0.36	0.49

[a] D = distinguished; S = strong; G = good; A = adequate plus.

[b] Defined as ranks professor through instructor; research associates, etc. excluded. "In research" refers to those with any current research activity, a category comprising from 68 to 88 percent of the total faculty for the institutions sampled.

[c] Temporary and permanent PhD-level staff in residence and active in research, not already counted in the line above. Some respondents seem to have misunderstood this question.

[d] Probably not correct--exactly the same for every rank and subfield.

[e] Perhaps with a slightly different definition from that for the other institutions.

[f] Research papers and letters.

[g] Approximate number from the Source Index of the *Science Citation Index*.

[h] From number of papers on which a department member was an author divided by average number of authors for U.S. physics papers.

[i] Nonfederal funds were 0.001 of total.

[j] Usually net (assignable space), rather than gross.

[k] Usually measured in terms of student credit hours.

[l] Not including employee benefits (of the order of 0.15 of salaries).

[m] On-campus work only.

[n] Obtained by subtracting estimated benefits from a total presumably including these.

TABLE III.21 Distribution of Effort among Subfields for a Sample of Universities[a,b]

Manpower and Funding Data	A&R	AME	NP	EP	P&F	CM	E&P	Opt	Acoust	Bio-phys	Other Phys
Faculty active in research[c] (8)	15.0	30.1	61.4	95.7	21.1	78.2	17.0	3.3	2.7	25.0	13.0
Nonfaculty staff[d] in research (8)	2.2	7.0	20.1	30.9	3.0	14.8	0	0	0	66.0	0
Man-months of outside support of faculty time, in year (7)	40.0	116.7	226.4	370.3	52.0	268.0	88.0	7.3	7.0	22.0	38.0
Man-months of outside support of faculty time, in year, per faculty member in research (7)	2.9	4.4	4.2	4.5	2.5	3.7	5.7	2.6	2.6	0.9	4.5
Outside support, in year (in $ thousands) (4)	163	928	3617	3663	286	1361	192	92	0	950	91
Outside support, in year, per total staff in research (in $ thousands) (4)	20	37	82	44	18	35	128	[e]	0	11	20

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[a] Figures in parentheses in the first column give the number of universities in the sample for which the datum in question was available; entries are totals for this group of universities or, where indicated, averages representing quotients of two such totals.

[b] Subfield abbreviations used are the same as those identified in Table III.1, footnote *b*.

[c] Entries are fractional because some faculty members were assigned partly to one subfield and partly to another.

[d] Temporary or permanent, PhD level. Totals probably are low because one institution apparently failed to report postdoctorals.

[e] One return listed support in optics but no staff in optics.

research for all universities by combining detailed data for these few universities with data on teaching loads from all, the expectation being that it would be possible to establish a plausible inverse correlation of time spent on research with teaching loads. Our success in this endeavor was only partial, as the university having the most detailed information did not return our questionnaire.

Let us consider first the extent to which teaching loads appear to be correlated with other factors of interest. Figure III.3 shows the sort of plot we would like to construct, depicting the fraction of faculty time allocable to research effort as a function of the average number of class-contact hours per week per faculty member. The two points plotted represent time spent in actual performance of research, as estimated for faculty of universities 5 (rough estimate only) and 8 of Table III.20. Because a certain fraction of administrative and other time is really allocable to

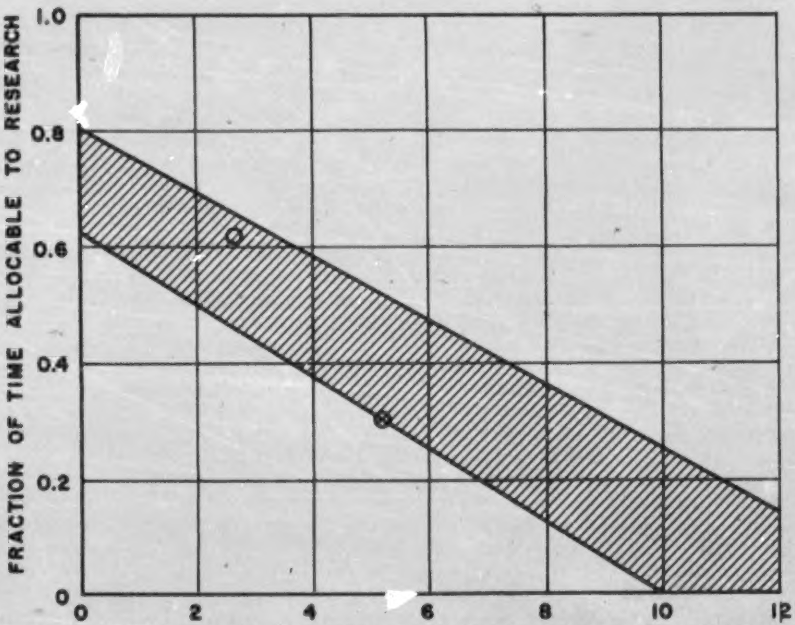

FIGURE III.3 Correlation of fraction of faculty time spent on research with average class-contact hours per week. Both figures represent averages over all parts of the year during which the faculty members in question were on campus. The shaded region, to be reproduced in Figure III.4, represents the range within which we believe that the average relation is fairly sure to lie.

research, these points provide rough lower limits for time spent on research. Common sense and general experience also provide some guides to how the curve should be drawn. For example, it is generally conceded that approximately 12 contact hours per week research simply disappear. On the other hand, low numbers of class-contact hours of course imply high concentration on research but do not mean that essentially all faculty time is allocable to research (as it could be in a noneducational research institution), for some will be devoted to administrative problems concerning graduate students and to nonclass educational activities for them. From data on such activities provided by one institution, we estimate that the extrapolation of the curve to the vertical axis should not have an ordinate higher than about 0.8. Combining these considerations with the two points shown, we have estimated rough upper and lower bounds for the fraction of time allocable to research, as shown by the two straight lines in the figure. The proper curve would undoubtedly not be a straight line, but we have not attempted to introduce this refinement into the bounds.

What is important, of course, is the difference between this time allocable to research and the amount of faculty time supported by funds from outside sources. In Figure III.4, faculty time supported by outside funds is plotted against class-contact hours for the seven universities for which reliable teaching data were available. Reproduced on the same plot are the upper and lower bounds to total time allocable to research, which were drawn in Figure III.3. The uncertainty in the difference--the university-supported time--is considerable and will be reflected in the estimates made in Section III.4.4.

In connection with the plots in Figures III.3 and III.4, it is interesting to see to what extent teaching loads are correlated with other variables. One might expect, for example, that there would be a significant inverse correlation with number of publications per faculty member. Such a finding was not true of our sample, as Figure III.5 shows. A plot of publications per PhD staff member in research (faculty plus nonfaculty) shows no correlation; one is tempted to conclude that at institutions with a less favorable climate for research the staff members choose problems that will require less expenditure of time to produce a publication. Another factor could be that some of these institutions have a higher ratio of graduate students to faculty than the institutions with lower teaching loads. The relevance of this factor is shown by Figure III.6, which depicts a positive correlation of publication rate with the ratio of graduate students to faculty.

The Cartter rating seems to correlate significantly with a number of variables. These include teaching loads (Figure III.7), publication rate (Figure III.8), and per capita costs and funding (Figure III.9).

Figure III.10 shows the distribution of what might be called the intensity of support among different subfields. The upper part of the figure, which is more meaningful than the lower because it is based on data from all eight institutions, shows the variation among subfields in the fraction of time of faculty members active in research that was supported from sources outside the university.

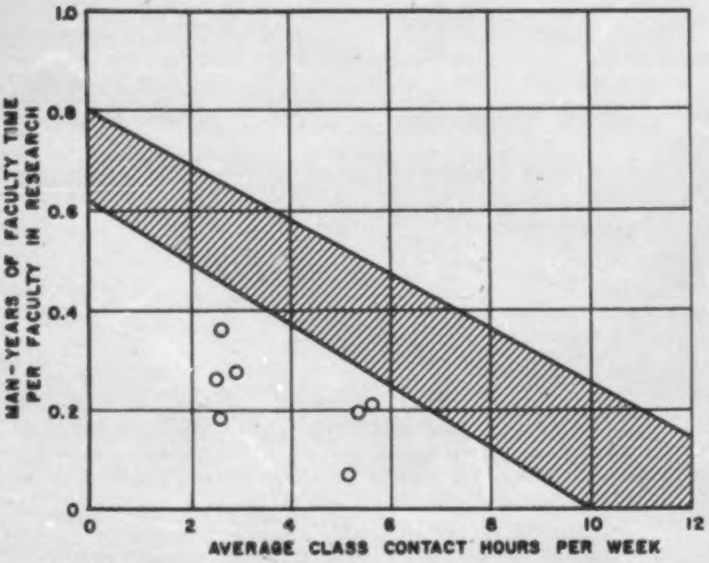

FIGURE III.4 Points: man-years of faculty time supported from sources outside the university, per faculty member in research, for each of seven universities, plotted as a function of average class-contact hours per week for these same faculty members. Shaded strip: range of probable fractions of time allocable to research, from Figure III.3 The distances of the points below the upper and lower boundaries of the shaded region thus represent university contributions to the support of research via faculty time, per faculty member.

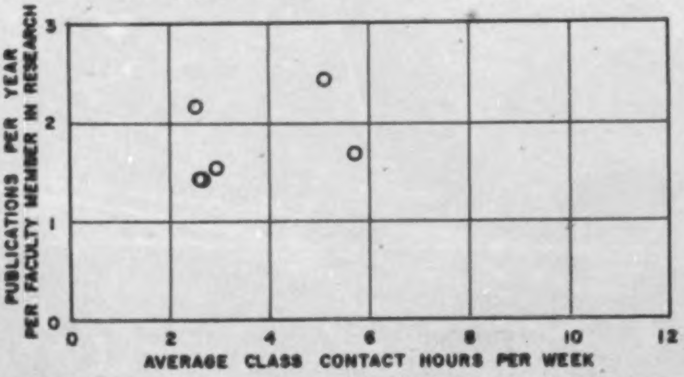

FIGURE III.5 Illustration of the lack of correlation between number of research publications per year per faculty member and average class-contact hours per week. Points represent universities 3 through 8 of Table III.20.

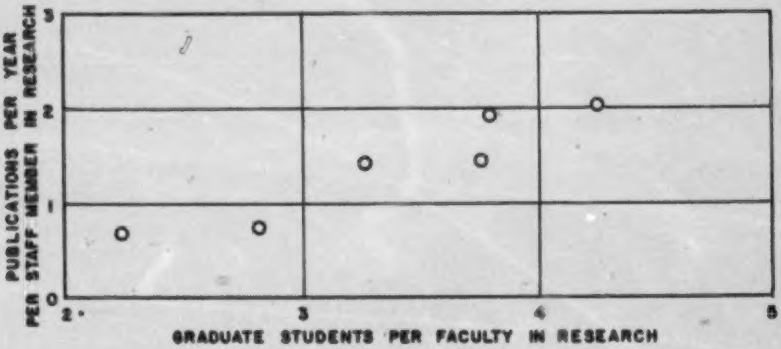

FIGURE III.6 Correlation of publications per year per staff member (faculty or nonfaculty PhD level) in research with number of graduate students per faculty member in research. Points for universities 3 to 8 of Table III.20.

This amount might be regarded as a measure of the intensity with which research in the various subfields is pursued, plus the ease of getting support. The lower part of the figure, based on data from only four universities, shows the distribution in amount of dollar support per staff member (faculty and nonfaculty). This distribution presumably depends on both the intensity with which research is pursued and the costliness of research in different subfields. Because of the rather large statistical fluctuations in the data, items other than those represented by bars of reasonable length (proportional to number of faculty or staff members, respectively, involved in the average) should be viewed with caution. Nuclear; atomic, molecular, and electron; and elementary-particle physics rank high in time supported, but nuclear physics is much higher than these other two subfields in dollars per person, presumably because most of the elementary-particle physicists in universities are theorists and because experimental work in atomic, molecular, and electron physics is less expensive. Physics in biology ranks especially low in both parts of the figure.

Outside support from sources other than the federal government was negligible in our sample, amounting to about $12,300 for the four universities giving full support data, compared with a total support of $1.2 million. This number, however, is based on only two projects, and it appears low in comparison with an earlier analysis of sources of research support cited in journal articles,[*] which showed 14.5 acknowledgments of nongovernment, nonuniversity support compared with 558.5 acknowledgments of government support.

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[*] Performed by Panel member R. W. Keyes, 12/22/70.

[†] *Physics Manpower 1969*. New York, N.Y.: American Institute of Physics, 1969 (pp. 26, 47).

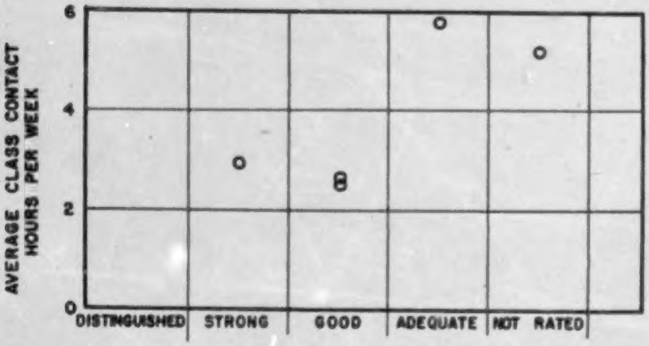

FIGURE III.7 Correlation of teaching loads with Cartter rating, for universities 3 through 8 of Table III.20.

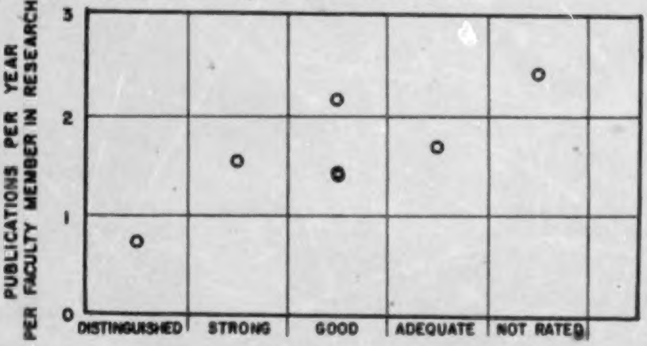

FIGURE III.8 Correlation (negative) of publication rate with Cartter rating, for universities 1 and 3 to 8 of Table III.20.

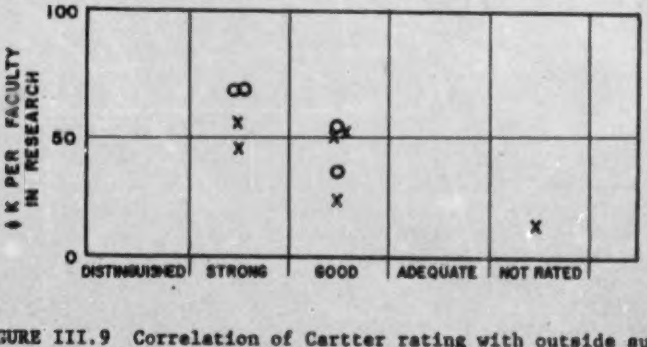

FIGURE III.9 Correlation of Cartter rating with outside support per faculty in research (circles) and nonsalary cost of research (crosses). Circles for universities 2,3,4, and 7 of Table III.20; crosses for 2 to 5, 7 and 8.

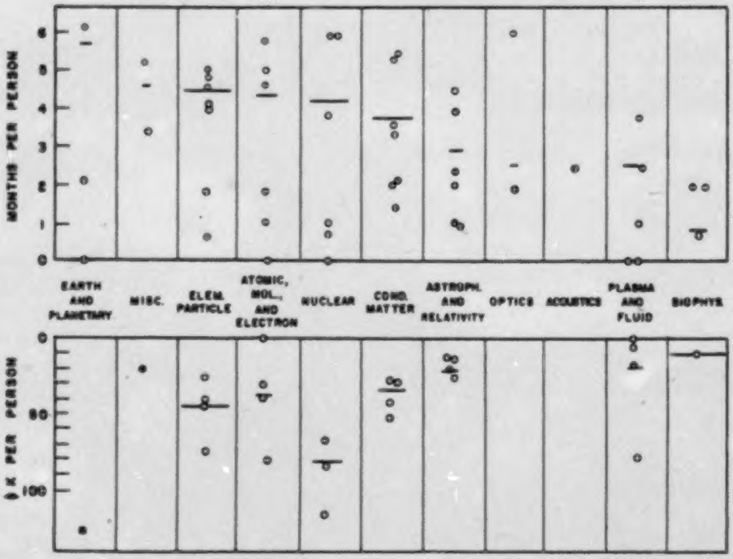

FIGURE III.10 Subfield distribution of average man-months of outside faculty salary support (top half, points for eight universities) and average dollar support per faculty member (lower half, points for four universities). Horizontal bars have ordinates representing weighted averages over all institutions and lengths proportional to total number of faculty members involved.

As indicated in Table III.20, the ratio of undergraduate majors to graduate students varied among the institutions sampled from 0.3 to 2.3, with an overall average of about one. Although our sample included only PhD-granting institutions, this ratio is almost the same as the ratio of national totals of undergraduate majors and graduate students in physics.†

Table III.20 also shows that approximately one fifth of the teaching effort (in student hours) in the departments sampled is directed toward students whose major fields are or will be other than science or engineering. A small fraction of the undergraduates who do not go on to graduate work, and a majority of the graduate students, is destined sooner or later to become teachers; however, only a few of the institutions sampled devoted any specific teaching effort in the physics departments to instructing graduate students in the art of teaching.

Estimates of the change, in the past two years, in university funds explicitly expended for research varied from department to department, from a decrease of 10 percent (contraction of department) to an increase of 20 percent. A rough weighted average of all institutions would yield an increase of about 7 percent.

III.4.4 ESTIMATES OF THE AMOUNT OF RESEARCH SUPPORT CONTRIBUTED BY THE UNIVERSITIES

In attempting to draw conclusions about all physics research in U.S. academic institutions on the basis of our sample, we must consider first how representative it is and what fraction of U.S. academic physics it represents. In regard to representativeness, Figure III.11 compares the relative volume of published material in the six categories of our sample with the relative volume from each of these categories in the 1967 *Physical Review*. A seventh category, non-PhD institutions, is included in the *Physical Review* data for completeness. Our sample is about right for the small institutions taken together (E and F, the non-PhD category being negligible), is a little high for the large institutions (A and B), and is deficient in the medium-sized institutions (C and D). However, its composition is fairly representative, and any errors resulting from

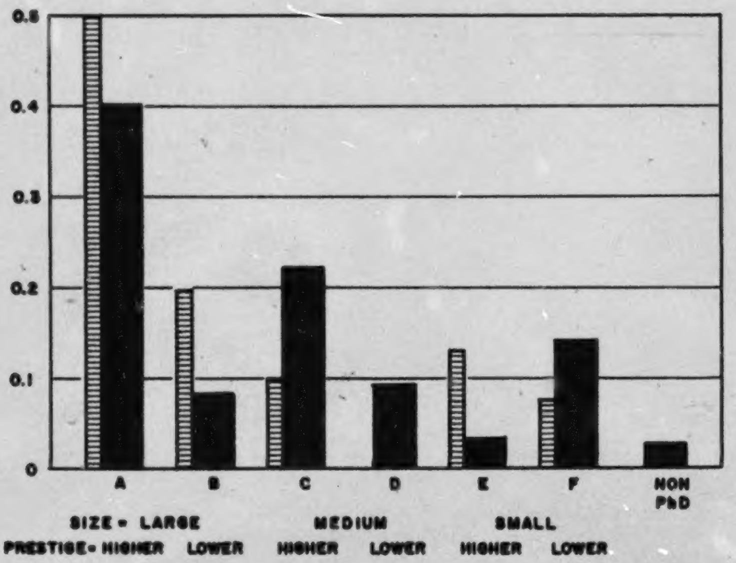

FIGURE III.11 Distribution of physics research papers over different types of U.S. academic institutions. The categories A to F are those described in Section III.4.1. The broad bars show the fraction of U.S. academic papers in the 1967 *Physical Review* originating from each of these six types of institutions and from non-PhD-granting institutions. The narrow bars show the distribution of total publications over the eight departments of our sample.

its distribution are probably much less than other uncertainties in the estimates that we will develop.

Because the data from institution 1 were deficient or unreasonable in several respects and our sample was slightly overweighted in Category A, we shall make our estimates of university funding on the basis of the other seven institutions, assuming them to constitute a properly distributed sample of all institutions. There are at least three possible measures for the size of this sample: One can compare the sample with all U.S. academic institutions in regard to volume of publication, number of graduate students, or number of doctoral degrees granted. The results of such comparisons appear in Table III.22. With due regard for the caveats in the figures for the upper extreme of the ranges indicated, we shall assume that the seven institutions account for a fraction of the support of physics research by U.S. academic sources amounting to between $0.058 million and $0.079 million in academic year 1968-1969.

TABLE III.22 Approximate Range of Support (in millions of dollars) of Physics Research by U.S. Academic Institutions through Loaded Faculty Salaries in the Academic Year 1968-1969

Fraction of Academic Work Assumed Sampled	Fraction of Faculty Research Time University Supported	
	Range	Mean
	0.156 - 0.357	0.257
0.058	12.6 - 28.8	28.8
0.0685 (mean)	14.8 - 34.0	24.4
0.079	17.1 - 39.2	28.1

Consider first the support contributed through the time that faculty members devote to research. If we take the distance of each point in Figure III.4 below the upper and lower boundaries, respectively, of the shaded region, weight by the number of faculty members involved, and average for the seven institutions, we obtain a fraction of faculty time allocable to research and supported by universities in the range 0.156 to 0.357. The corresponding estimates of university-supported faculty man-years of research are 41.4 and 97.7, respectively. With a mean overhead factor for these universities of about 0.5 (see Table III.20) and a mean 12-month salary of about $16,000, we estimate this university contribution at about $24,000 per man-year; thus, the effective contribution of these seven universities through support of faculty time was, according to our estimates, in the range $993,000 to $2.272 million. Combining these bounds with the estimates given in the preceding paragraph, we obtain the estimates shown in Table III.22 for that part of the contribution of U.S. universities to the support of physics research in 1969 associated with their support of loaded faculty salaries. Thus we estimate this contribution at about $24 million, with an accuracy that should be within a factor of 2 in either direction.

The second of the categories of support mentioned in the Introduction, equipment and non faculty staff, is much less amenable to quantitative assessment but seems likely to constitute an amount considerably smaller than the other two categories, space and faculty time. Our original hope had been to estimate this quantity by finding the difference between the figures provided for (a) nonsalary cost of research and outside support received and (b) that part allocable to faculty-salary support. Unfortunately, not all the departments supplied these figures, and some of those that did misinterpreted the question, with the result that the quantities to be subtracted were not comparable. A more promising approach is to look at a sample of papers in the literature (see Section III.1) and note the frequency and characteristics of papers originating in universities and not acknowledging support from nonuniversity sources. In the sample studied, about 24 percent of the articles originating in universities appeared to have only university support. This figure is higher than that suggested by the sketchy data in Table III.20 and also higher than that found in a more recent study of a smaller sample; therefore, it may have included a number of papers with outside support that the authors failed to acknowledge. In this more recent sample, we found that the names of the authors of papers without outside support were more often those of faculty members than was true of the supported papers, and there was a predominance of theoretical over experimental papers. Although the nonfaculty authors are occasionally senior research associates and the like, probably the vast majority of them is graduate students or postdoctorals, these categories being represented in comparable numbers. A rough estimate of the mean salary of these authors would be about $6000 per year. Overhead for them should be less than for faculty members (for example, smaller offices) but not as much less as the bare salaries; we shall assume a mean value of $5000 per year. If we assume that the average paper without outside support requires an amount of nonfaculty time of the order of two thirds the amount of faculty time involved in the average of all papers, we have

$$\frac{\text{(total nonfaculty time without outside support)}}{\text{(total faculty time [supported or not])}} \approx 0.24 \times \frac{2}{3} = 0.16. \tag{6}$$

$$\frac{\text{(university support through nonfaculty time)}}{\text{(university - outside support through faculty time)}} \approx 0.16 \times \frac{11}{24} = 0.073. \tag{7}$$

This amount is much smaller than our earlier estimate of the fraction of faculty research time that is university supported (0.83 to 0.59). Probably some of the nonfaculty time spent on projects that have outside support is not fully covered by this support; however, all indications are that the university-supported portion of such time is much less than for faculty members, and as the loaded salary rate is less than half that for faculty members, we cannot escape the conclusion that this category of university support is much smaller than that provided through faculty time.

There is some further evidence, although sketchy, that supports this conclusion. For example, about 0.18 of the beyond-second-year graduate student population is supported by teaching assistantships.* These are probably the main source of university support of such students. The number of graduate students past the second year is about half the total number* or almost twice the number of faculty active in research (Table III.20). If the research involvement of graduate students with teaching fellowships is assumed to be somewhat less intense than that of other students at the same level, say, about equal to that of faculty members, one gets an estimate for the graduate student part of the left of Eq. (6) of the order of twice the value given there. This amount is not large, as the salary factor for these students will be smaller than is assumed in Eq. (7). Yet another source of information is the data on PhD-level nonfaculty staff provided by our sample. About 0.17 of this staff time was university supported, of which no more than 0.01 was attributable to classroom teaching. Thus the contribution of this doctoral-level staff to the left of Eq. (6) would be only 0.16 times the ratio of time spent on research by these staff members to that spent by faculty, a number doubtless considerably less than 1 (see Table III.20).

We consider last the resources contributed by universities in support of research through plant construction. To develop an estimate one must decide on a way of converting capital investment in the past into equivalent current expenditure. Suppose a building that would cost $C^{(0)}$ dollars to reproduce today was constructed at time Δt in the past, costing C dollars at that time. We shall assume

$$C = C^{(0)}\, e^{-\alpha\Delta t}. \qquad (8)$$

If these C dollars had remained in the university's endowment, with the income spent each year, the income foregone each year would be βC, where for a reasonably conservative investment policy $\beta = 0.04$. For a large number of institutions i we therefore have

$$\text{Income foregone} = \beta < e^{-\alpha\Delta t} > \Sigma C_i^{(0)}, \qquad (9)$$

where the angular brackets imply an average over all the Δt_i's, weighted in proportion to their $C_i^{(0)}$'s, in other words, with each yearly unit of Δt having a weight proportional to the dollar value of construction in that year. This we assume to be given by

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Physics Manpower 1969. New York: N.Y.: American Institute of Physics, 1969 (p. 49).

$$\text{weight} \propto e^{-\gamma\Delta t}. \tag{10}$$

Combining Eqs. (9) and (10) we get

$$\text{Income foregone} = \left(\frac{\beta\gamma}{\gamma+\alpha}\right) \Sigma C_i^{(0)} . \tag{11}$$

A further intangible but economically real factor should probably be added: The money invested in a building is not liquid and its unavailability hampers the economic freedom of the institution. We shall rather arbitrarily assume that this effect can be taken into account by adding about 0.01 to the β in Eqs. (1) and (11); this is roughly equivalent to a policy of amortizing the investment over about one century. The value of α can reasonably be taken from the average increase in construction costs over the past 15 years, namely, $\alpha = 0.04$ per year. Gamma can be estimated either by subtracting α from the average rate of increase of funds for physics in the United States, which, from Figure X.3 of Volume I of *Physics in Perspective*, was approximately 0.13 per year, or, alternatively, can be set roughly equal to the rate of growth of PhD-level manpower in U.S. universities, which, from Table XII.9 of the same volume, has been about 0.10. Averaging these two estimates and taking our sample of seven universities as representative of between 0.058 and 0.079 of the U.S. academic enterprise, we get

$$\begin{aligned} &\text{Effective contribution of U.S. academic} \\ &\text{institutions to the support of physics} \\ &\text{research, through building construction} \\ &\approx \frac{0.05 \times 0.095}{0.135} \times \frac{\$75 \times 310{,}700}{0.058 \text{ to } 0.079} \\ &= \$10.4 \text{ million to } \$14.1 \text{ million} \end{aligned} \tag{12}$$

for the academic year 1968-1969. We have used a value $75 for the cost per square foot of assignable space, about 1.5 times the cost per square foot of growth space; the figure, 310,700 square feet, is just the sum of the products of square feet by fraction of cost from university funds, using the entries in Table III.20.

To summarize our calculations, we estimate that the total contribution to physics research from U.S. university funds in the academic year 1968-1969 was probably a little more than $40 million, over half of it through support of faculty time and most of the rest through plant construction. This estimate could easily be too small or too large by a sizable fraction of its value.

III.5 Growth in Costs of Research in Physics

The cost of research in physics, measured, for example, by dollars per professional man-year, has been steadily rising. It is generally accepted that this increase is compounded in comparable amounts from the general decrease in purchasing power of the dollar and a sophistication factor resulting from the increasing complexity of equipment required to expand research into new and ever more difficult areas. Comments on this sophistication factor appear occasionally in the reports of the subfield panels, for example, in Figure XI.1 of Volume II, Part B, of *Physics in Perspective* (costs of nuclear magnetic resonance equipment) or in the tables of Chapter II of Volume II, Part A (listing characteristics of accelerators throughout the world). Our contribution to this subject will be minor, consisting merely of an analysis of some figures issued by the AEC* and some estimates of cost escalation obtained in our survey of industrial funding (Section III.3).

The AEC's *Statistical Summary* series* annually reports dollar expenditures, scientific man-years of effort, and other statistics pertaining to various parts of their physical research program. For each of the years, 1960-1970, we have compared the reported cost for various categories of AEC work with the reported number of scientific man-years, a figure that apparently includes faculty and other types of professional employees but not graduate students, even though they may be paid. We have computed these ratios for the categories, high-energy physics, low-energy physics, and metallurgy and materials. Metallurgy and materials consists largely, though by no means entirely, of research in physics of condensed-matter.

The principal results obtained from the AEC data are presented in the two top curves of Figure III.12. Here, the cost in thousands of dollars per scientific man-year is plotted against year. The AEC Statistical Summaries report expenditures in federally funded research centers of the AEC and in the AEC contract program or universities separately. The figures used here for universities represent the total program expenditure not just the AEC contribution. The dashed line in each part of the figure, drawn at arbitrary height, shows the behavior of the general price index for federal government purchases of goods and services. At the bottom of the figure analogous data on changes in cost per man-year for research in physics, obtained from the Survey of Industrial Laboratories (Section III.3), are shown.

Although the trends in the AEC data are partially obscured by large apparently random fluctuations, the steady increase in dollars per man-year on the average is evident. The straight lines, which were fitted to the logarithm of the dollar expenditure per man-year by the method of least-squares, have slopes of 3.0 percent per year for work in universities and 6.1 percent per year for the federally funded research and development centers. The fluctua-

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A Statistical Summary of the Physical Research Program (U.S. Atomic Energy Commission, annual).

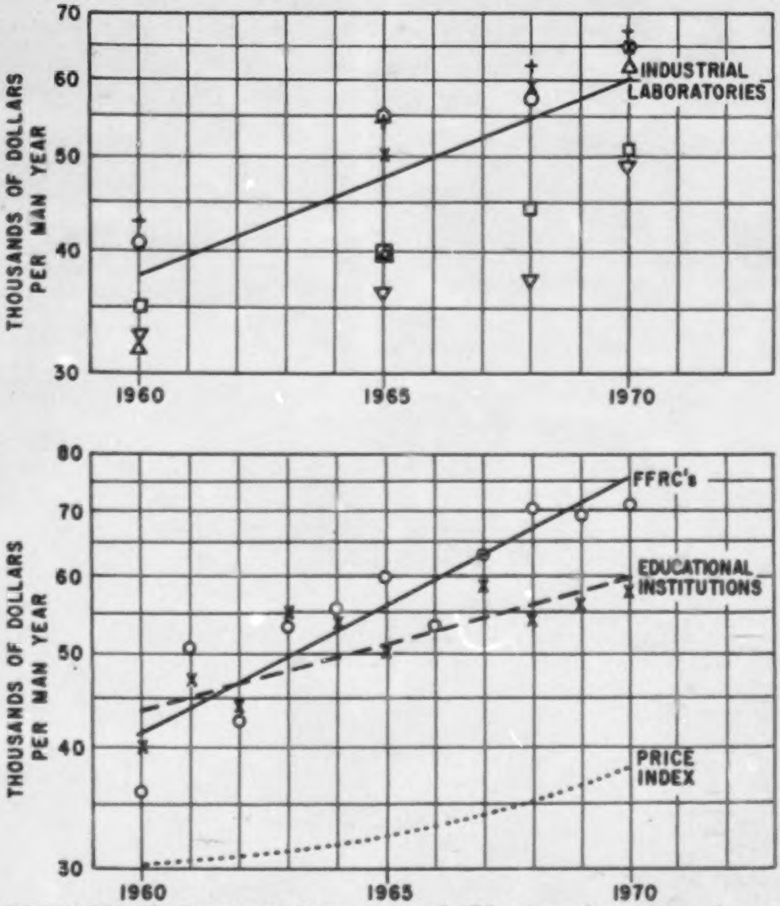

FIGURE III.12 Top: growth in costs of AEC research programs in areas predominantly physics, per scientific man-year, 1960–1970. Circles and full line: programs in federally funded research centers. Crosses and dashed line: programs in universities. The lines in both cases are least-squares fitted through 1969. Middle curve: price index for government purchases. Bottom: research costs per scientific man-year for the six categories of industrial laboratory surveyed in Table III.17.

tions appear to consist mainly of some kind of budgetary artifact. For example, the low cost in the federally funded research and development centers in 1966 results almost entirely from reports from both the Cambridge Electron Accelerator and the Princeton-Pennsylvania Accelerator of 200 more man-years of effort in 1966 than in

1965 or 1967, without any comparable anomaly in the reported total funding. In general, most flucutations in the cost per man-year in the figure represent fluctuations in man-years of effort reported rather than in dollar expenditures for the Physical Research Program.

If the various subfields are separated, the flucutations are, of course, even more pronounced. Least-squares fits to the data give the result shown in Table III.23. One must be cautious in interpreting these numbers, however. First, they are subject to changes in definitions; what is recorded as nuclear physics was known as nuclear structure physics earlier in the decade, became low-energy physics in 1963, and was further affected by the introduction of a budget line for medium-energy physics in 1966. In 1966, many of the funds of low-energy physics were apparently allocated to the medium-energy program without any comparable change in manpower, leading to a rather large anomaly in the cost per man-year in nuclear physics in universities from 1965 to 1966.

The penultimate row of Table III.23 gives the average rate of increase in cost per man-year reported by our sample of industrial laboratories (Section III.3).

All the figures, even including those from the industrial survey, may be somewhat too low to reflect adequately the sophistication factor, in that all groups undoubtedly suffered a certain amount of so called "belt tightening" during the late 1960's.

TABLE III.23 Rates of Increase (percent per year) in Cost per Scientific Man-year in Different Parts of the Atomic Energy Commission Research Program in Physics (FY 1960–1970) and in U.S. Industrial Laboratories

AEC Category and Industry	Location of Work		
	FFRDC[a]	University	Industry
AEC Program Category			
High energy	8.1	0.8	
Low energy	3.0	-0.2	
Metallurgy and materials	6.4	4.4	
Total of above	5.8	2.9	
AEC average	3.8		
Industrial laboratories			4.7
Price index	2.9		

[a] Federally funded research and development center

IV
DATA ON THE LITERATURE OF PHYSICS

IV.1 Production and Distribution

IV.1.1 PROBLEMS OF DISCIPLINE AND SUBFIELD CLASSIFICATION: OVERLAPS

In Section II.1.1 we discussed the problems of determining who is and is not a physicist and assigning physicists to the various subfield panels of the Physics Survey. Similar problems arise in the enumeration and classification of physics publications. In "Dissemination and Use of the Information of Physics,"* for example, tables and figures showed the relative proportions of the physics literature in different subfields, countries, and types of institutions. Construction of these tables required answering, for each paper sampled, two questions: first, "Is it physics?" and if the answer was affirmative then, "To which subfield should it be assigned?" More important, an intelligent understanding of the structure and dynamics of the physics enterprise requires a knowledge of the extent to which one subfield overlaps another and the extent to which research in physics overlaps activities in related disciplines such as chemistry, engineering, and earth sciences. Answers to these questions usually have to be based on subjective judgments. However, careful subjective judgments can be much better than sloppy ones, and there are

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*[*] *Physics in Perspective,* Volume II, Part B, Chapter XIV; condensed version in Volume I, Chapter 13.

objective methods of getting the answers that, though moderately laborious and not necessarily unique, are by no means impossible to use and, without excessive labor, can provide at least spot checks on the correctness of subjective judgments.

There are a variety of measures of the relatedness of different parts of the scientific literature that, though subjective in that they depend on the judgments of individuals, are objective, in the sense in which the term is used here, in that they constitute a statistical verdict of the entire scientific community. These measures are based on citations of one paper by another. Suppose that two groups of papers, *i* and *j*, have been selected in any manner. As a measure of the relatedness of *i* to *j* we may take any of the following:

1. The fraction of the references in papers of group *i* that are to papers of group *j*, averaged with the fraction of *j*'s references that are to papers of *i*;
2. The fraction of the references of *i* that are also references of *j*, averaged with the fraction of *j*'s references that are shared by *i* (the concept[*] of bibliographic coupling);
3. The number of papers in all areas that contain citations to both a paper of *i* and one of *j* (the cocitation concept[†]).

Suppose that the universe of scientific literature we wish to consider has been divided into a number of groups *i*, *j*, ..., and suppose for simplicity that each of these groups contains the same number of papers. (This is to avoid having a large group appear especially close to the others simply because of its size.) Then by using any of the three criteria—most simply the first one—one can define the relatedness of *i* to *j* by a number c_{ij} with the properties

$$1 \geq c_{ij} = c_{ji} \geq 0, \tag{1}$$

$$\sum_j c_{ij} = 1. \tag{2}$$

We would like to be able to interpret these numbers geometrically by assigning to each group *i* a point in a space of some dimensionality and so placing these points that c_{ij} is a universal decreasing function of the distance of point *i* from point *j*. Although this, of course, can be done only approximately in any small number of dimensions, there are mathematical procedures for locating the points in a space of any assumed dimensionality in such a way as to give the best possible approximation.[§] For our purpose it will suffice to consider a simpler problem, that of assigning positions to a number of borderline groups i, relative to other groups k whose positions are taken as given. The simplest such case would be, for example, one in which one locates the groups i on a one-dimensional scale between, say, pure physics (assigned coordinate $x_k = 0$) and pure chemistry (assigned coordinate $x_{el} = 1$). Almost as simple would be the assignment of positions in a triple overlap area, say, that of atomic physics, condensed matter, and optics, with each of these subfields assigned to one corner of an equilateral triangle in a two-dimensional space. In assigning positions to groups i in the overlap region, we would like to make the assignment self-consistent in the sense that the position allotted to any given i would be a weighted average of the positions allotted to other areas with which it is connected, with weights σ_{ij}. In other words, we would like to get a solution of the equations

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[*] Kessler, M.M. *American Documentation*, *14*, 10 (1963): *16*, 223 (1965); Price, D. J. de S. *Science*, *149*, 510 (1965).

[†] Small, H. *Journal of the American Society for Information Science*, in press.

[§] Kruskal, J. B. *Psychometrika*, *29*, 1 (1964).

$$\vec{r}_q = \sum_p \sigma'_{qp} \vec{r}_j + \sum_\alpha \tilde{\sigma}_{q\alpha} \vec{R}_\alpha, \tag{3}$$

where p and q now run only over groups in the overlap region, and α runs over all the groups whose coordinates we have agreed to fix in advance. For the physics-chemistry case, for example, this would mean that all areas α considered to be unquestionably physics are assigned $R_\alpha = 0$, and all those considered to be unquestionably chemistry are assigned $R_\alpha = 1$. In matrix form the solution to Eq. (3) can be written

$$\vec{r} = (1 - \sigma')^{-1} \tilde{\sigma} R, \tag{4}$$

and the solution is unique as long as the matrix $(1 - \sigma')$ is nonsingular. Now the series

$$1 - \sigma' = 1 - \sigma' - \sigma'^2 - \ldots \tag{5}$$

converges if the matrix σ' is bounded with a bound less than unity. And since Eq. (2) is equivalent to

$$\sum_p \sigma'_{qp} = 1 - \sum_\alpha \tilde{\sigma}_{q\alpha}, \tag{6}$$

a slight generalization of a familiar argument* shows that σ' is indeed so bounded unless there exist groups q, which are not connected to any of the given groups α by any chain of citation connections. Barring this possibility then, we can say that any given group q is, for example x percent chemistry and $(1 - x)$ percent physics, or that it is x percent atomic physics, y percent condensed-matter physics, and $(1 - x - y)$ percent optics.

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*Courant, R., and D. Hilbert, *Methods of Mathematical Physics* (Interscience, New York, 1953), Vol. I, p. 19.

Although the groups *i* that we have been talking about may be composed by any procedure that selects a reasonably coherent group of papers—for example, they might be composed by using the finest subdivisions of the *Physics Abstracts* subject classification scheme—it is interesting to note that an algorithm for computer generation of clusters of closely related papers, based on the statistics of citations, has been developed and is rather effective*.

As an example of what can be done with this approach, consider the question: Should work on quantum fluids be considered in the province of the Panel on Plasma Physics and Physics of Fluids or should it be grouped with solid-state physics in the province of the Panel on Physics of Condensed-Matter? A sampling of citations in a number of theoretical and experimental papers on quantum fluids in *Physical Review Letters* and *Physical Review A* gave the following distribution for the cited papers:

Quantum fluids	72
Other physics of fluids	2
Solid-state physics	19
Instrumentation	1

The intuitive judgment of the panelists that quantum fluids should be grouped with condensed-matter is confirmed.

A number of spot checks of this sort were made to verify the reasonableness of the assignment of papers by panelists to various disciplines and subfields or to an overlap area. These checks generally confirmed the intuitive assignments, although occasionally they showed the assignment to be wrong.

Some rough indications of the extent of the overlap among the different subfields, the ambiguity in the definition of the boundaries between physics and neighboring disciplines, and the uncertainties in each of these two measures can be obtained from the results of classification of papers in two samples drawn from *Physics Abstracts* by a member of the panel. These are presented in Tables IV.1 and IV.2, respectively. For the sample of Table IV.1, a restricted definition of overlap areas and an inclusive definition of physics were used: A physics paper was not assigned to an overlap area between two subfields unless it was really difficult to decide to which it should be given; similarly, papers were considered as physics unless they belonged fairly indisputably to some other discipline. For the sample in Table IV.2, in contrast, a liberal definition of overlap and a fair definition of the boundaries of physics were used: A paper was assigned to an overlap area of two or more physics subfields whenever a reasonable case could be made for its belonging in each of them; a paper was considered as physics only if its relation to the rest of physics was judged to be closer than its relation to the more central

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*Price, N., and S. Schiminovich, *Information Storage and Retrieval, 4*, 271 (1968); Schiminovich, S. *Ibid.*, *6*, 417 (1971).

TABLE IV.1 Distribution of a Sample of U.S. Papers from *Physics Abstracts* among Subfields of Physics on the Basis of an Inclusive Definition of Physics and a Restricted Definition of Overlap[a]

Subfield	Papers Judged as Within This Subfield		Papers Judged as Overlapping This Subfield and Another		Number Overlapping Each of Other Subfields										
	No.	Fraction	No.	Fraction	A&R	AME	EP	NP	P&F	CM	E&P	PB	Opt	Acoust	Misc
A&R	9	0.90	1	0.10	-	-	-	-	-	-	1	-	-	-	-
AME	82	0.84	16	0.16	-	-	-	1	4	5	-	-	4	-	2
EP	61	0.95	3	0.05	-	-	-	3	-	-	-	-	-	-	-
NP	47	0.90	5	0.10	-	1	3	-	-	-	-	-	-	-	1
P&F	54	0.86	9	0.14	-	4	-	-	-	2	3	-	-	-	-
CM	245	0.93	19	0.07	-	5	-	-	2	-	-	-	8	2	2
E&P	36	0.78	10	0.22	1	-	-	-	3	-	-	1	4	1	-
PB	9	0.45	11	0.55	-	-	-	-	-	-	1	-	5	5	-
Opt	21	0.49	22	0.51	-	4	-	-	-	8	4	5	-	-	1
Acoust	13	0.59	9	0.41	-	-	-	-	-	2	1	5	-	-	1
Misc	18	0.72	7	0.28	-	2	-	1	-	2	-	1	-	1	-
Total															
Physics	595		$56 = \frac{112}{2}$												
Nonphysics	6%														

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[a] Subfield abbreviations used are: A&R = astrophysics and relativity; AME = atomic, molecular, and electron physics; EP = elementary-particle physics; NP = nuclear physics; P&F = plasma physics and physics of fluids; CM = condensed-matter physics; E&P = earth and planetary physics; PB = physics in biology; Opt = optics; Acoust = acoustics; Misc = miscellaneous.

TABLE IV.2 Distribution of a Sample of U.S. Papers from *Physics Abstracts* among Subfields of Physics on the Basis of a Fair Definition of Physics and a Liberal Definition of Overlap[a]

Subfield	Papers Judged as within This Subfield		Papers Judged as Overlapping This Subfield and Another		Number Overlapping Each of the Other Subfields								
	No.	Fraction	No.	Fraction	A&R	AME	EP	NP	P&F	CM	E&P	PB	Opt, Acoust and Misc
A&R	6	0.67	3	0.33	-	-	1	-	-	-	2	-	-
AME	33	0.60	22	0.40	-	-	-	5	5	10	1	-	1
EP	26	0.84	5	0.16	1	-	-	3	-	-	1	-	-
NP	45	0.79	12	0.21	-	5	3	-	-	3	-	-	1
P&F	17	0.63	10	0.37	-	5	-	-	-	4	-	-	1
CM	138	0.82	31	0.18	-	10	-	3	4	-	1	1	12
E&P	13	0.65	7	0.35	2	1	1	-	-	1	-	1	1
PB	3	0.60	2	0.40	-	-	-	-	-	1	1	-	-
Op, Ac, & Misc	32	0.67	16	0.33	-	1	-	1	1	12	1	-	-
Total Physics	313		$54 = \frac{108}{2}$										
Nonphysics	6	(13.5%)	51		4	9	-	2	4	28	-	-	4

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[a] Subfield abbreviations used are the same as those identified in Table IV.1, footnote *a*.

areas of some other discipline such as chemistry or engineering. The study depicted in Table IV.2 was done before the panel decided to separate optics and acoustics from the miscellaneous category, thus these are grouped together.

Although most of the subfields show more overlap in Table IV.2 than in Table IV.1, as one would expect, a few do not, and this finding must be attributed to statistical fluctuations. From the two tables together it is evident that the subfields that are most nearly self-contained are elementary-particle physics, nuclear physics, probably astrophysics and relativity, and condensed-matter. For the first three this finding is undoubtedly the result of their being so specialized; for condensed-matter, it is probably due to the vast size of the subfield. Optics and acoustics appear to have large overlaps with other subfields, as does earth and planetary physics also. Atomic, molecular, and electron physics and plasma physics and physics of fluids have moderately high overlap. Among the core subfields, condensed-matter has the largest absolute overlap into other disciplines simply because of its large size, but percentagewise the overlap of atomic, molecular, and electron physics into other disciplines (principally chemistry) is greater. The data on overlap into nonphysics disciplines are much less meaningful, of course, for the peripheral subfields of physics, since their coverage in *Physics Abstracts* is often incomplete. (This situation is especially true for physics in biology.)

A different type of measure of the overlap of physics with other disciplines can be obtained from the professional self-identification of the authors of physics papers. As we shall see in Section IV.1.3, about half of the authors of papers covered by *Physics Abstracts* identify primarily with a nonphysics discipline even though, according to Table IV.2, 87 percent of the papers so covered probably lie on the physics side of a fair boundary.

IV.1.2 SAMPLING OF ABSTRACT JOURNALS

Our objectives in sampling entries in abstract journals were to get information about

1. The distribution of physics publications among subfields;
2. The geographic distribution of total publication and of work in each subfield;
3. The degree of correlation between the country or region in which work is done and the country or region in which it is published;
4. Changes in time in some of these quantities;
5. The distribution of U.S. work in the various subfields among different types of performing institutions;
6. Any differences between theoretical and experimental papers in regard to the previous five categories. (We classified papers as theoretical when they did not contain any new experimental results or report the testing of new experimental techniques.)

To achieve most of these objectives one needs to know the location of the performing institution and, for U.S. papers, its identity. In *Physics Abstracts* this information became available only in 1969, so our sampling from this source (our most extensive sampling project) was confined to this one year. *Nuclear Science Abstracts* has recorded the performing institution for a number of years; therefore, we studied small samples from this source for both 1964 and 1969.

The principal results from our sampling study of 1969 issues of *Physics Abstracts* have been given previously* and will not be repeated. We shall merely recapitulate the ground rules for the study and add a couple of supplementary tables. Two physicists (R. W. Keyes, C. Herring) performed the sampling, one looking at all entries in 13 of the 26 issues for 1969 with numbers ending in 5, the other looking at all entries in 16 of the issues with numbers ending in 0. Entries not in the category "published research papers" were discarded. Published research papers were defined as presentations of new research results in articles or letters in periodicals or books available on the open market; this definition excluded theses and reports available only from a research institution, agency, or clearinghouse, also patents, reviews, popularizations, and abstracts of talks unaccompanied by a text. Each paper not so discarded was classified into one of the ten subfields of physics corresponding to the panels of the Physics Survey or into a miscellaneous physics category or (in rare cases) as outside physics. These judgments were made subjectively by each sampler but according to the guidelines described in Section IV.1.1. Each paper was assigned to a country of origin according to the location of the first-named institution in the by-line, except when the institution was operated by an international organization, then the assignment "international" was used. Papers for which no institution was named were distributed statistically among performing regions by noting the location of the publisher of the paper and using the correlation found for other papers (or occasionally by direct sampling of journals) between region of publication and region of performance. For papers from U.S. institutions, the institutions were further classified as academic, industrial, government in-house laboratories, federally funded research and development centers (i.e., national laboratories), or other.

Table IV.3 obtained from the Keyes half of the sample, shows how publications reporting work performed at various types of U.S. institutions were distributed among journals and books published in different locations. Journals of the AIP are listed separately from other U.S. publications. The AIP journals receive about 54 percent of the U.S. work, a fraction that is fairly constant among all types of institutions. Note, however, that the definition of physics used in this sampling was the inclusive one employed in developing Table IV.1; if the fair definition used in Table IV.2 had been used, the AIP percentage undoubtedly would be moderately higher.

**Physics in Perspective*, Vol. II, Part B, Tables XIV.9, XIV.10, and XIV.11 and Figures XIV.31 and XIV.32.

TABLE IV.3 Place of Publication of Physics Papers from Different Types of U.S. Institutions[a]

Performing Institution	Total Papers	Publication in[b]: AIP Journal	Other U.S. Publications	Foreign Publications: U.K.	Continental W. Europe
Academic	386	206	86	29	65
Industrial	146	80	40	14	12
Govt. (in-house) laboratory	61	27	16	4	14
Federally funded research and development center	67	40	10	2	15
Other	13	8	1	1	3
TOTAL	673	361	153	50	109
PERCENT	100	54	23	7	16

[a] Data from sample drawn from *Physics Abstracts* in 1969.

[b] Articles published in Eastern Europe, Japan, and other regions are omitted from this table; accord[illegible] Table XIV.9 of Volume II, Part B of *Physics in Per*[illegible]*e*, these constitute only about 2 percent of the total n[illegible]f physics papers.

TABLE IV.4 Distribution of Physics Research Papers Among Different Types of Performing Institutions[a]

Performing Institution	Total Papers	Subfields[b]: AME & P&F	EP & NP	CM	Opt, Acoustic, Misc	E&P
Academic	389	82	76	135	42	50
Industrial	148	17	4	96	22	9
Govt. laboratory						
DOD	24	2	2	11	4	4
NASA	13	1	1	2	2	7
Other	26	8	4	6	2	6
Federally funded research and development center						
AEC	64	9	18	28	7	2
Other	6	0	0	1	1	4
Other	15	3	2	5	2	2
TOTAL	694	122	107	284	82	84

[a] Subfield abbreviations used are the same as those identified in Table IV.1, footnote *a*.

[b] Astrophysics and relativity and physics in biology are excluded from the subfield breakdown but included in the total.

Table IV.4, also based on the Keyes sample, gives the distribution of U.S. papers among different types of U.S. performing institutions in somewhat more detail than was given previously.* Despite small-number statistics, such trends as the emphasis of NASA laboratories on earth and planetary physics and that of DOD laboratories on condensed-matter are evident.

Table IV.5, based on the sampling of *Nuclear Science Abstracts*, shows the geographical distribution of nuclear physics work in 1964 compared with 1969. The last column shows, for comparison, the distribution obtained from the 1969 sampling of *Physics Abstracts*. This comparison gives a clue to the relative coverage of the two abstracting services. In all tables of this sort, sampling fluctuations are probably rather larger than one would infer from the $N^{1/2}$ rule, since the papers are not received at random but in groups corresponding to issues of journals or books. Conferences have an especially serious effect, since a large conference, even if international, held in country A results in a large burst of papers from A's delegation. This effect may partially, though by no means entirely, explain the spectacular shift in relative positions of France and West Germany between 1964 and 1969.

A check of *Nuclear Science Abstracts* against *Referativnyi Zhurnal, Fizika* for 1965 and 1969 indicated that *Nuclear Science Abstracts* misses few Soviet papers that satisfy the criteria that we have used for inclusion, probably only a few percent. It seems, however, that *Nuclear Science Abstracts* misses many more of the papers in the other countries of Eastern Europe, possibly about one third. (Many of the relevant journals are not even on the list scanned by *Nuclear Science Abstracts*.) Coverage of Japanese-language material in *Nuclear Science Abstracts* appears to be good.

IV.1.3 THE WORLD'S POPULATION OF PUBLISHING PHYSICISTS

IV.1.3.1 *Goals*

Although there are many sources of information about people who might be called physicists—for example, the files of the National Register, membership lists of scientific societies, and data on recipients of degrees—it is widely recognized that a large proportion of these people do not engage in research, at least if this activity is defined as work leading to publication in the archival research literature. It would be interesting to know how many people there are who engage in this activity, how they are distributed among the major nations, and something about their productivity. For example, how are they distributed in regard to the frequency with which they publish? How extensively is collaboration involved in their publication? How do these characteristics vary with geographic area?

Although a number of pertinent statistics about publications in physics have been collected by the Data Panel and others and are

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Physics in Perspective, Volume II, Part B, Table XIV.11 and Figure XIV.32.

TABLE IV.5 Comparison of the Geographical Distribution of Institutions Publishing Papers Listed in Samples from *Nuclear Science Abstracts* in 1964 and 1969[a]

Location of Performing Institution	1964 Theoret	1964 Exp	1964 Total	1969 Theoret	1969 Exp	1969 Total	1969 Phys. Abst.[b]
United States	69	114	183 (0.34)	146	219	365 (0.33)	(0.27)
Other No. America	8	9	17 (0.032)	25	26	51 (0.046)	(0.059)
So. America	2	4	6 (0.011)	5	1	6 (0.005)	(0.002)
United Kingdom	9	16	25 (0.046)	29	35	64 (0.058)	(0.039)
France	9	50	59 (0.11)	18	36	54 (0.049)	(0.025)
W. Germany	7	11	18 (0.034)	35	70	105 (0.095)	(0.11)
Other W. Europe	18	47	102 (0.19)	45	79	124 (0.11)	(0.11)
U.S.S.R.	28	61	89 (0.165)	69	65	134 (0.12)	(0.14)
Other E. Europe	7	12	19 (0.035)	22	27	49 (0.044)	(0.049)
Africa	2	6	8 (0.015)	6	9	15 (0.014)	(0.016)
Japan	5	11	16 (0.030)	20	21	41 (0.037)	(0.055)
India	4	12	16 (0.030)	33	19	52 (0.047)	(0.023)
Other Asia	6	1	7 (0.013)	6	12	18 (0.016)	(0.021)
Australia and N.Z.	2	6	8 (0.015)	6	6	12 (0.011)	(0.021)
International centers	0	3	3 (0.006)	4	7	11 (0.010)	—
Unknown	-	-	-	-	-	-	(0.047)
World total in sample			539 (1.00)			1101 (1.00)	427

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[a] Fractions of the world total appear in parentheses.

[b] Fractions for nuclear physics papers in the samples from *Physics Abstracts* 1969 reported in Table XIV.10 (a and b) of Volume II, Part B, of *Physics in Perspective*.

summarized in other volumes of *Physics in Perspective*,* such counts of papers do not answer all the questions posed in the preceding paragraph. They show, for example, that the United States currently publishes about one third of the physics research papers covered by *Physics Abstracts* but leave unanswered the question whether the United States might have more than one third of the publishing physicists who are less productive than average of less than one third who are more productive.

IV.1.3.2 *Methodology*

The study we report was made on the papers in *Physics Abstracts* for the five years 1965–1969. Its geographic bias thus reflects that of *Physics Abstracts*, and we have not attempted to correct for this. Our sample consisted of all names in the following five intervals of the alphabet:

Bacchi to Backhurst (inclusive)
Edelman to Edmonds (inclusive)
Kini to Kinzly (inclusive)
Ovsyuk to Ozawa (inclusive)
Vasudevan to Vavilov (inclusive)

All names in any of the 1965–1969 author indexes that were in any of these intervals were recorded, and the total number of papers referenced for each such name was tabulated.

Each name was then assigned to a nation or geographic region. To make this assignment, a variety of measures had to be employed. Fortunately, many of the names could be found in the publications *Who Is Publishing in Science* and *International Directory of Research and Development Scientists*, issued by the Institute for Scientific Information. Names for which no address was located in these publications were checked against the membership directory of the APS, or the author's institution as recorded in *Physics Abstracts* (1969 only), *Physikalische Berichte*, or the title page of the original paper. By these and (occasionally) other means, national identification was achieved for essentially all names in the sample.

From these data we tabulated the number of authors in the alphabetical intervals sampled who had written one, two, or any number, s, of papers in the given five-year period and the number of these in each country or region. The relative numbers from the different countries will not, of course, be highly reliable, for it could well have happened that, for example, the alphabetical intervals chosen provided an underrepresentation of Russian names or an overrepresentation of those of some other nationality. However, as fairly reliable data are already available† on the national and regional distribution of total papers published, it is sufficient if the present study merely supplies reasonably reliable data on how prolific the authors of different nations are. Such data are presumably not sensitive to alphabetical selection, though they are subject to limitations resulting from the small size of the sample.

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*Volume II, Part B, Chapter XIV; condensed version in Volume I, Chapter 13.

†*Physics in Perspective*, Volume II, Part B, Tables XIV.10a and XIV.10b.

A much more serious worry in regard to the interpretation of the data is the question of how many of the authors should be designated physicist. Not only does *Physics Abstracts* cover a moderate amount of material that is closer to chemistry, engineering, geology, or some other science than to physics, but many people who consider their primary professional affiliation to be with one of these other disciplines occasionally write papers that are well within the scope of physics. A sampling of physics papers for a period of years will reveal many authors who do not consider themselves physicists. To provide a rough estimate of this effect, the U.S. authors in our sample were checked against the listings in *American Men of Science*. The professional identification of the authors listed in this publication was recorded. Many of the authors in our sample were not so listed, but it is reasonable to suppose that the distribution of their professional identifications would not be greatly different from that of the others.

IV.1.3.3 *Raw Results*

Table IV.6 shows the distribution of authors in regard to number

TABLE IV.6 Distribution of Authors in the Alphabetical Intervals Sampled, by Geographical Location and Number of Papers Contributed to the Listings of *Physics Abstracts* in 1965–1969

Country or Region	No. of Authors	No. of Authors Whose Names Appeared on				Papers per Author	Total Papers	Fraction of Papers Sampled	Fraction[a]
		1	2	3–4	≥5 papers				
United States	138	56	27	27	28	3.03	418	0.36	0.34
United Kingdom	55	27	7	10	11	2.82	155	0.13	0.08
Other W. Europe	68	34	11	12	11	2.71	184	0.16	0.19
U.S.S.R.	35	20	1	9	5	3.94	138	0.12	0.19
Other E. Europe	9	4	1	2	2	3.4	31	0.03	0.01
Japan	36	10	6	9	11	4.75	171	0.15	0.06
Other Asia	7	3	1	2	1	2.1	15	0.01	0.05
Other	12	8	1	1	2	2.8	34	0.02	0.06
World total	360	162	55	79	71	3.19	1147	1.00	1.00

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[a] From *Physics in Perspective*, Volume II, Part B, Tables XIV.10a and XIV.10b.

TABLE IV.7 Professional Self-Identification of U.S. Authors in the *Physics Abstracts* Sample

Discipline or Group of Disciplines	Designations Used[a]	No. of Authors	Papers by These Authors
Physics	Physics (9); nuclear physics (4); solid-state physics (3); physics, mathematics (2); physics, biophysics (2); theoretical physics (2); 6 other combinations containing the word physics	28	101
Fields difficult to assign	Electrical engineering, solid-state physics; applied mathematics, continuum mechanics; mechanics, metrology; physiological optics; vision	4	25
Astronomy	Astronomy (2); astronomy, astrophysics; theoretical astrophysics	4	25
Chemistry	Physical chemistry (6); physical and inorganic chemistry; chemistry; agricultural chemistry	9	37
Metallurgy, etc.	Physical metallurgy (2); ceramics; ceramics, metallurgy; physical metallurgy, electron microscopy; materials science, metallurgy	6	18
Biology	Zoology; biochemistry; anatomy	3	4
Total, all disciplines		63	227

[a] The word or words between semicolons are those used by an author to describe his field in *American Men of Science*. If more than one author used the same words, the number of such authors is indicated in parentheses.

of papers published during the five-year interval and geographic areas in which they were based. It also compares the geographic distribution of the papers with that in the more comprehensive literature sample. Our sample undercounts papers from the U.S.S.R. and overcounts those from the United Kingdom; the numbers from other regions are in reasonable agreement.

Table IV.7 shows the distribution of professional identifications of those U.S. authors who could be located in *American Men of Science*. Note that at least half of the authors identify with a discipline outside physics, although these authors, as might be expected, contribute a slightly smaller fraction of the total papers.

IV.1.3.4 *Discussion and Analysis*

Our goal was to find out how many people are engaged in the research enterprise of physics. Unfortunately, this population is far from stationary in time. New people are continually entering and many leave. It has often been said, in fact, that many authors publish only one paper during their lifetime, for example, a thesis. We would like if possible to separate these authors from those with a continuing commitment—not necessarily lifelong—to research activity. A plausible though far from unique way of making such a separation is suggested by the semilogarithmic plot in Figure IV.1. Here, the points representing number of authors associated with s or more papers in our five-year sample lie reasonably well on a straight line for $s \geq 2$, but the point for $s = 1$ lies well above the line. Now there is a simple model that would predict a straight line for such a plot, namely, one that assumes that each author published at random times with an average rate r papers per year and that the distribution of authors per unit range of r is exponential:

$$n(r)dr = \nu e^{-\alpha r}dr \ . \tag{7}$$

Indeed, according to the Poisson distribution, the fraction of authors of productivity r who publish s papers in Δt years is

$$\text{fraction} = \frac{e^{-r\Delta t}[r\Delta t]^s}{s!} \ . \tag{8}$$

Combining Eqs. (7) and (8) we get for the number of authors publishing s papers in Δt years

$$N(s) = \frac{\Delta t^s}{s!} \int_0^\infty \nu e^{-\alpha r} e^{-r\Delta t} r^s dr = \frac{\nu \Delta t^s}{(\alpha + \Delta t)^{s+1}} \ , \tag{9}$$

and the number publishing s or more papers is

$$\sum_s^\infty N(s') = \frac{\nu}{\alpha}\left(\frac{\Delta t}{\alpha + \Delta t}\right)^s \tag{10}$$

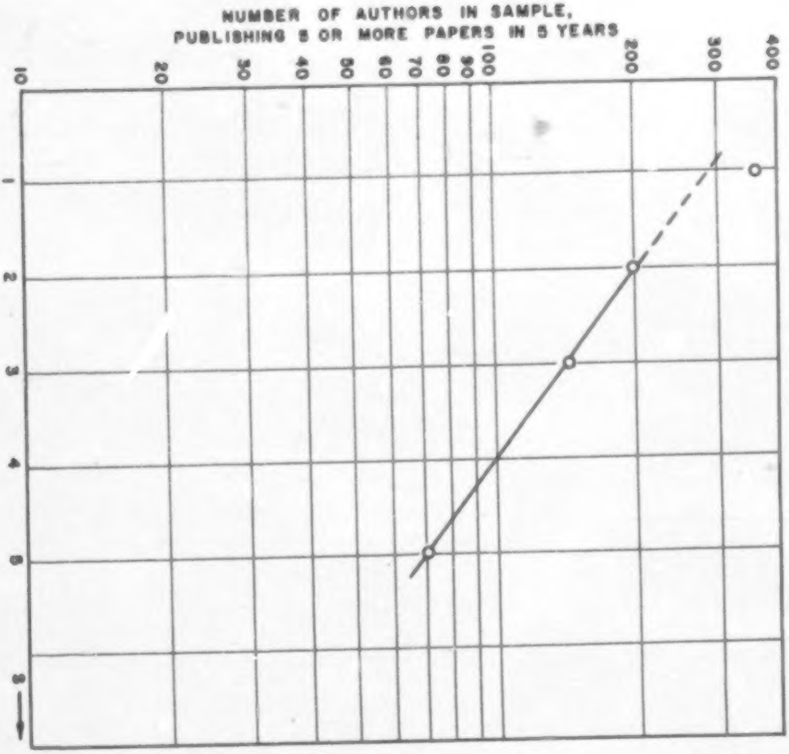

FIGURE IV.1 Semilogarithmic plot of cumulative totals from the last line of Table IV.1, showing the excessive number of one-paper authors.

The form (7) that we have assumed for $n(r)$ is rather arbitrary and doubtless less accurate than one more like Lotka's law*

$$\sum_{s}^{\infty} N(s') \approx s^{-2} \text{ for } \Delta t \text{ equal to a lifetime}$$

or its generalizations, but it is clear that the large value for

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*Price, D. J. de S. *Little Science, Big Science*. New York, N.Y.: Columbia University Press, 1963, pp. 42 *et seq*.

$s = 1$ must come from a peak in $n(r)$ as very low r. So we shall undertake to analyze our data under the crude assumption that there are simply two populations of authors, those who publish once and those who publish continuously, the continuously publishing groups having a distribution of the form (7) for their rates of publication.

Accordingly, we shall undertake to fit the data of Table IV.6 by assuming that for any particular geographic region the number of authors attached to s papers in our sample is given by Eq. (9) for $s \geq 2$, but that for $s = 1$ it is the sum of Eq. (9) and a term $\varepsilon\Delta t$. Table IV.8 shows the results obtained by fitting the three parameters ν, α, and ε to the total number of authors, the number with two or more papers, and the number with five or more. The paramenters so obtained can be used to predict the number associated with either three or four papers, and this number can be compared with the observed number as a check on the model, as we do in the table.

Comparing the top line of the table with the bottom one, we see that the number of transients, or one-paper authors, appearing in the five-year period is only a fraction of the population estimated to be active in research. The active population figure, of course, includes an allowance for those authors who are considered to be in research but who, through chance or their possession of a low publication rate, do not happen to have published any papers during the five-year period sampled. (This allowance factor is obvious, for the entries in the last column of the table are larger than the author entries in Table IV.6.) If one wishes to exclude such low publishers from the total considered to be part of the research community, one can compute a new total from the same model by employing a lower cutoff in the integration on r.

The totals for limited sections of the alphabet must still be converted into totals for the whole alphabet, and, less trivially, the distribution of authors between those who would be designated physicists and those who would be associated primarily with some other scientific or engineering discipline must be estimated. The conversion to the entire alphabet can be made in either of two

TABLE IV.8 Fit of World and U.S. Data of Table IV.6 to the Three-Parameter Model Described in Section IV.1.3.3

Parameters and Associated Quantities	World Data	U.S. Data
5 = number of transients	82.1	20.6
ν	792	362.8
α, years	2.04	2.16
$N(3) + N(4)$, predicted	70	29
$N(3) + N(4)$, observed	72	27
Number permanently in research = ν/α	388	168

ways: We can compare the number of columns of the author index sampled with the total size of this index, or we can compare the number of papers associated with names in the sample with the total number of papers in *Physics Abstracts*. The second approach is less straightforward, for one must allow for multiple authorship of papers. Thus if N authors publish P papers in a given interval, with an average of $\overline{m}$ authors per paper and an average of $\overline{p}$ papers associated with each author, we have

$$P\overline{m} = N\overline{p} \; . \tag{11}$$

We can get N for, say, a given volume of *Physics Abstracts*, from the number P of papers in it, an estimate of $\overline{p}$ from Table IV.6, and an estimate of $\overline{m}$ from some other source. With the estimate $\overline{m} = 2.06$, obtained from a rather limited sample of articles,* and with $\overline{p} = 2.52$ from Table IV.6, we get, for the entire five-year period, a total of about 133,000 authors publishing one or more papers. The uncertainties entering into this estimate are such that it is only to be regarded as a rough check on the estimate obtained from the size of the fraction of the author index that was sampled, which was 0.00280 of the alphabet. Dividing this number into the total of 360 authors in Table IV.6 yields a value of 127,500 for the number of authors contributing items to *Physics Abstracts* in this five-year period. The agreement between the two figures being reasonable, we shall perform all further calculations using the assumption that 0.00280 of the entire population has been sampled.

The most plausible way to make the division between physicists and nonphysicists is simply to add to the total of authors in the physics row of Table IV.7 one half of the total for the next row and to consider the other half of this row and all the remaining rows as nonphysicists. This procedure gives 32/63 as the physicist component of the sample. One might wonder whether the fraction determined in this way to be physicists would depend on the number of papers published, but in the data from which Table IV.7 was prepared such dependence seems to be slight. Our final estimates of the number of persons identifying themselves as physicists and with a continuing activity in physics research, as of the average time 1967, are obtained by multiplying the figures in the last row of Table IV.8 by 32/63 (0.00280):

Number in the world ≈ 70,400;
Number in the United States ≈ 30,500.

These numbers are, of course, quite crude, as the discussion of their derivation makes clear. Still, it is impressive that they are so large. For example, the U.S. figure may be compared with the total of 32,500 physicists in the 1968 National Register, a figure one might expect to contain many nonpublishing people, or with the unduplicated membership of all member societies of the AIP, 42,700 in 1967, a number that doubtless not only contains many nonpublishing people but also many who identify primarily with another discipline.

**Physics in Perspective*, Volume II, Part B, Chapter XIV, Section 4.5.

One other feature, evident in Table IV.6, should be noted: The average number of papers associated with a given author is much higher in Japan (4.75) than for the world as a whole (3.19). Although the Japanese sample was fairly small (36 authors), the difference is nearly two and one half standard deviations and could well be significant.

IV.1.4 PHYSICS THESES

To provide information about physics theses to the Physics Survey Committee, the Data Panel examined all the abstracts in the physics section of *Dissertation Abstracts*[*] from January through June 1970. The theses represent degrees awarded in 1969. Each thesis was classified according to physics subfield, whether it was experimental or theoretical, and size of the PhD program of the university.

The size classification was based on the list of PhD-awarding institutions appearing in the March 1969 issue of *Physics Today*.[†] Any institution listed as awarding 20 or fewer PhD's in the five-year period, 1962–1967, was regarded as having a small program; those awarding more than 20 PhD's in that period were classified as large programs. *Physics Today* lists 137 PhD-awarding institutions, and 67 of these are small programs, so that 20 is about a median size for that time interval. About 10 percent of the PhD's were awarded by the small programs, according to the list in *Physics Today*.

The following limitations on data from *Dissertation Abstracts* must be noted:

1. Not all PhD-granting institutions send their theses to *Dissertation Abstracts*. Four of the large programs and nine of the small ones, which were responsible for 11.5 percent of the PhD degrees reported by *Physics Today* are not covered by *Dissertation Abstracts*. Furthermore, not all participating institutions send all their theses to *Dissertation Abstracts*.
2. Classification by subject field is made by the author of the thesis; therefore, it is not certain that all theses listed under physics represent work performed for a degree in physics.

The total number of theses in the sample was 597, which can be compared with about 1400 PhD's in physics awarded in 1969. Thus, total numbers per year can be estimated by multiplying the numbers in the sample by 2.34. Since the sample is for half a year, we assumed that about 85 percent of all physics theses appear in *Dissertation Abstracts*.

The results are summarized in Table IV.9. The first two columns give the number of theses in the sample by subfield and size of

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[*] *Dissertation Abstracts International*, periodical publication of University Microfilms, Ann Arbor, Michigan.

[†] *Physics Today*, 22(3), 46 (March 1969).

TABLE IV.9 Production of Physics Theses in 1969

Sub-field[a]	Theses in Sample: Large Univ.	Theses in Sample: Small Univ.	Est. Total[b]	NRC Total[c]	Percentage of all Physics(%)	Percentage Theoretical(%)	Percentage Small Univ. (%)
A&R	5	3	19	-	1.3	100	38
AME	37	17	127	127	9	39	31
EP	64	16	188	220	15	55	20
NP	80	16	225	188	16	28	17
P&F	29	1	70	85	5	67	3
P	22	1	54	61	4	61	-
F	7	0	16	24	1.2	86	-
CM	189	57	577	360	41	22	23
E&P	23	10	77	-	6	39	30
PB	2	0	5	-	0.3	-	-
Opt	15	2	40	16	3	6	12
Acoust	9	1	23	11	2	50	10
Misc, general	15	6	49	304	4	67	29
TOTAL	468	129	1400	-	-	35	22

[a] Subfield abbreviations used are the same as those identified in Table IV.1, footnote *a*.

[b] Obtained by multiplying the sum of the numbers in the preceding two columns by 2.34

[c] *Doctorate Recipients from U.S. Universities 1969.*

PhD program. The third column gives the estimated total number of theses in each subfield, obtained by multiplying the sum of the first two columns by 2.34. The fourth column compares these numbers with those obtained from *Doctorate Recipients from United States Universities 1969*,* for those subfields for which there is a roughly equivalent NRC category. Many theses that belong in a subfield apparently appear in the general and other categories of *Doctorate Recipients*. The fifth column lists the percent of theses in each subfield according to the sample. The numbers are obtained by dividing column 3 by 1400. The sixth column gives the percentage of theoretical theses, defined as those that contain no new experimental information. The differences among subfields are not unexpected. The final column lists the percentage of theses from universities with small PhD programs.

To investigate changes in the distribution or number of theses with time, the Data Panel also surveyed the abstracts of physics theses in the January through June issues of *Dissertation Abstracts* for 1966. These abstracts refer to theses awarded in 1965. The numbers appear in Table IV.10, which is similar to Table IV.9. Com-

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**Doctorate Recipients from United States Universities*, annual publication of the National Research Council, Washington, D.C.

TABLE IV.10 Production of Physics Theses in 1965

Subfield[a]	Theses in Sample: Large Univ.	Small Univ.	Est. Total[b]	NRC Total[c]	Percentage of all Physics(%)	Percentage Theoretical(%)	Percentage Small Univ. (%)
A&R	8	0	18	-	1.8	62[d]	0
AME	32	10	96	111	9	36	24
EP	65	2	153	180	15	63	3
NP	88	3	208	158	20	30	3
P&F	25	1	60	-	6	58	4
P	22	1	53	-	5	-	-
F	3	0	7	32	0.6	-	-
CM	146	19	378	299	36	23	12
E&P	26	6	73	-	7	31	19
PB	3	1	9	-	0.9	0	-
Opt	4	1	11	13	1.1	20	-
Acoust	0	0	0	7	0	-	-
Misc, general	16	1	39	122	4	75	-
TOTAL	413	44	1045	-	-	34	9

[a] Subfield abbreviations used are the same as those identified in Table IV.1, footnote *a*.

[b] Obtained by multiplying the sum of the numbers in the preceding two columns by 2.29.

[c] *Doctorate Recipients from U.S. Universities 1958-1966.*

[d] Two experimental studies of gravity and one cosmic-ray experiment were classified as astrophysics and relativity.

parison of the two tables shows a growth in the number of theses in all subfields. Significant changes in the distribution are difficult to find, although the decrease of the fraction of theses in nuclear physics and the increase in the fraction in condensed-matter are perhaps meaningful. The fraction of theoretical theses also did not change. The most striking difference is the increase in the proportion of PhD's awarded by institutions that were classified as small on the basis of the 1962–1967 listing. In 1965, these institutions awarded 9 percent of the PhD's included in the *Dissertation Abstracts* sample, consistent with the number of such programs obtained from the *Physics Today* list, 10 percent. By 1969, these same institutions awarded 22 percent of the PhD's. In fact, according to these samples, 57 percent of the increase in PhD production from 1965-1969 is in the small institutions (201 of 355). A slight distortion of the comparison results from an increase in the coverage of *Dissertation Abstracts* between 1965 and 1969, which included two of the large institutions awarding 82 PhD's in the 1962-1967 period and nine additional small programs responsivle for 22 PhD's.

TABLE IV.II Distribution of Citations in Journals of the Institute of Electrical and Electronics Engineers

Year	Total Journal Citations	Citations to Physics Journals	Percent	Citations to U.S. Physics Journals	Percentage of Physics Citations to U.S. Journals(%)
1965	13,763	3015	22	2437	81
1949	1,643	293	18	210	72
1934	1,567	331	21	110	33

IV.1.5 PHYSICS CITATIONS IN THE ENGINEERING LITERATURE

Several surveys of sources of citations to the journal literature in publications of the Institute of Electrical and Electronics Engineers (IEEE) (formerly the American Institute of Electrical Engineers and the Institute of Radio Engineers) have been made.* The substantial number of citations to the physics literature indicate continuing dependence of electrical and electronics engineering on physics. Table IV.II shows the distribution of citations.

The category, physics journals, includes the following: all journals published by the AIP, *Soviet Physics JETP, Proceedings of the Physical Society, Journal of the Physical Society of Japan, Journal of Physics and Chemistry of Solids, Canadian Journal of Physics, Proceedings of the Royal Society, Journal of Mathematics and Physics, Zeitschrift für Physik, Annalen der Physik, Japanese Journal of Applied Physics, Physica, Philosophical Magazine*, and *Helvetica Physica Acta.* Of course, there are other physics journals, but others do not appear in the list of journals cited. A more difficult problem pertains to interdisciplinary journals such as *Nature*. Undoubtedly, a certain amount of physics is represented in citations to *Nature*, but, as there is no way to measure this amount, they are not counted in the citations to physics journals.

Apparently, physics journals have accounted for about 20 percent of the journal citations in the electrical engineering literature for many years. The ratio persisted through the rapid expansion of the IEEE publication program during the 1950's.

The other striking feature of the table is the steady growth of the fraction of citations to journals published in the United States. The same trend would certainly emerge in counts of physics publications, but it is interesting and perhaps more significant to see it confirmed by a study of the use of the literature.

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*Coile, R.C. *IEEE Transactions on English Writing and Speech. EWS-12*, 71 (1969); *Proceedings of the Institute of Radio Engineers, 38*, 1380 (1950); *Journal of Documentation (London), 8*, 209 (1952); Dalziel, C. F. *Electrical Engineering, 57*, 110 (1938); *Library Quarterly, 7*, 354 (1937).

IV.2 Use and Usefulness

Numerous small sampling and observational studies of the use of the literature of physics were made during the course of the Physics Survey and have been reported, together with earlier studies by others, in Chapter XIV of Volume II, Part B, of *Physics in Perspective*. The purpose of this section is to add a small postscript to what was written then by describing one further study that was not then sufficiently advanced to discuss. Even now, only sketchy results are available, so the methodology may be of more value than the results.

The study was designed to find out how well the typical active research physicist succeeds in maintaining awareness of work published in other countries that has an important bearing on his own interests. This question is basic to many decisions on information services: Elaborate schemes to improve current awareness are hardly worthwhile, for example, if physicists are already in touch with all the information they are interested in trying to assimilate. The key words in the question we hoped to answer are "*important* bearing on *his own* interests." Although one might argue that many physicists do not know what is important to their own interests, one is usually on rather shaky ground in trying to overrule the judgment of the persons whose interests are involved. Consequently, the best way to set up a study of this question would seem to be to base it on value judgments of the individuals concerned, which was the approach adopted in our study.

A physicist, whose own interests led him to scan a rather wide range of literature on condensed-matter, selected numbers of articles from those he encountered in browsing through non-U.S. publications—articles that he considered likely to appeal to the interests of some 30 of his colleagues. From time to time he provided each of these colleagues with a one-paragraph résumé of those aspects of a paper likely to interest him and the bibliographic reference. Such distributions were made only after at least six months had elapsed from the time the article became available in the library but less than 18 months after this time. The colleague would examine the material and answer two types of questions about it, as shown on the form reproduced in Figure IV.2. The questions of II enabled the returns to be analyzed in such a way as to make the results almost independent of the quality of the initial selection of articles: Only returns on which II.1 or II.2 were checked were counted. There were no failures to respond.

Some typical preliminary results appear in Table IV.12. The numbers are so small that sampling errors could be substantial, but they suggest that about half of the non-U.S. literature items that U.S. physicists would be interested in taking time to examine may fail to come to their attention within the first year after their appearance. The loss entailed is considerably mitigated, however, by the general redundancy of the literature: In many cases similar results or ideas are put forward by several investigators.

The study was so designed that figures could be separately tabulated for experimentalists and theorists and for articles in foreign languages. Further studies of this sort would be of substantial interest.

I. Previous familiarity with the item. (Check one.)

1. I had previously seen enough of this item to evaluate its degree of interest for me. ____

2. I had heard of this item, but had not evaluated its interest. ____

3. I had not heard of this item, but was already aware of results equivalent to those quoted in the communication on it. ____

4. I had not heard of this item, and was not aware of the results quoted in the communication on it. ____

II. Interest in this item. By checking one of the three alternatives below, please indicate whether this item was of low, medium or high interest to you, the boundaries being defined by whether it was of greater or lesser interest to you than (a) median of all articles of which you read at least the abstract, or (b) the median of all articles of which you read nearly all of the text.

1. Interest of this $<$ median of abstracts. ____

2. Median of read abstracts $\leq$ interest of this $\leq$ median of read articles. ____

3. Interest of this $>$ median of read articles. ____

FIGURE IV.2 Evaluation form for physicists queried about journal articles.

TABLE IV.12 Familiarity of a Sample of Physicists[a] with Results of Interest to Them Published in Non-U.S. Journals and Available for at Least Six Months[b]

	Degree of Interest[c]			
Degree of Familiarity	At Least as High as Median of Abstracts Read (Categories II.2 + II.3)		Higher than Median of Articles Read (Category II.3)	
Seen or heard of:	12		4	
Evaluated (Category I.1)		11		3
Not evaluated (Category I.2)		1		1
Not heard of:	12		4	
Aware of similar results (Category 3)		6		1
Not aware of result (Category 4)		6		3

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[a] Respondents were theoreticians in nine cases, experimentalists in 15.

[b] Entries are numbers of cases.

[c] In addition to the 24 cases tabulated, there were six discarded replies checking item II.1.

V

INDEX OF DATA

This chapter is devoted to a crude but, it is hoped, usable index to socioeconomic data contained in all the volumes of *Physics in Perspective*, including the present one. (Data of a purely scientific rather than socioeconomic nature are not included in this index, although they occur frequently in the earlier volumes. Diagrams that are schematic, rather than quantitative, are also omitted.)

The organization of the index is based on the categories of independent and dependent variables that we described in Section I.2.1. Each table or figure has been classified, first, according to the nature of the quantity tabulated or plotted as ordinate and, second, according to the variable or variables on which its functional dependence is shown. Using the terms "dependent variable" and "independent variable" for these two categories, respectively, we shall arrange the index according to the various combinations as follows:

DEPENDENT VARIABLES

People. Numbers or proportional amount of
  Manpower, (Employable) (ME)
  Manpower, (Students) (MS)
Money. Dollar figures or proportional amounts of
  Funding ($F). Money assigned to broad programs of scientific research, etc.
  Other money ($O). Salaries, income, GNP, costs of equipment, etc.
Publications (P). Numbers or proportional amounts of articles, books, etc.
Miscellaneous (Misc.). All quantities plotted or tabulated, other than people, money, or publications.

INDEPENDENT VARIABLES

Time.

Discipline. Physics, chemistry, geology, etc. or, occasionally, physical sciences, biological sciences, etc.

Subdiscipline. Smaller groupings than the above, most often the subfields of physics.

Activity. Such distinctions such as basic and applied research, development, management, teaching, etc.

Geographical. Distinction of one country or one region from another.

Institution or type of institution. This may refer to one or more specific institutions performing work in physics or, more often, to the distinction between types of institutions, such as universities, industrial laboratories, government laboratories.

Support source. Agency or sector of the economy from which work is supported.

Degree or rank. Most often this contrasts holders of doctoral degrees (usually designated "PhD," though ScD, etc. are included); sometimes academic faculty rank is used or, for students, the level.

Age.

For a given dependent variable, not all the independent variables just listed will be of interest. For example, the last two are relevant only if the dependent variable is one of the "people" type. In the tables below, only the more important independent variables are used. We have omitted those that were found to occur seldom or never among the tables listed.

Whenever a table or figure specializes its data to one or several values of an independent variable, there is an index entry corresponding to this variable. If the data refer to only one value of the variable (e.g., if the variable is subdiscipline and the data refer only to nuclear physics), the entry is the numeral 1, or, in certain important cases, a special abbreviation—when the data refer to the United States, the entry in the Geographical column is "U.S."; when they refer to physics, that in the Discipline column is "P". If they refer to two values of the independent variable, the entry is 2; this entry is also usually used, for example, when the data contrast one subfield with all the rest of physics. If the data are separated according to more than two values of the independent variable, the entry is X.

The right half of each index page contains additional information that may be useful.

Source. This is an abbreviated clue to the source of the data. Not all sources are identified, but the following are (though only in cases where the nature of the source was obvious to the indexer): The National Register of Scientific and Technical Personnel (R); other questionnaires to individuals or to organizations (Quest.); records of government agencies supporting R&D (Ag); records of other organizations (Rec); abstracting-indexing publications (A&I); research journals (J); scientific and technical literature in general (Lit.); editors (Eds.); interviews (Int.).

Remarks. Any combination of words or symbols that will provide, within the small space available, a clue to the subject matter of the index entry. For the subfields of physics corresponding to the panels of the Physics Survey, the usual abbreviations are used: Astrophysics and Relativity (A&R); Atomic, Molecular, and Electron Physics (AME); Elementary-Particle Physics (EP); Nuclear Physics (NP); Plasma Physics and Physics of Fluids (Pl.&Fl.); Physics of Condensed Matter (CM); Earth and Planetary Physics (E&PP); Physics in Biology (Ph. in Biol.); Optics (Opt.); Acoustics (Acoust.).

Item. Preceding the colon is the relevant volume of *Physics in Perspective*; following it is the figure (F) or table (T) number or, occasionally, some other designation to identify data material.

Cross entries. When a figure or table supplies data of more than one of the dependent-variable types enumerated above (e.g., supplies both funding and manpower data), it will, of course, be entered in more than one place in the index. In such cases, each entry contains, in the last column, the abbreviations for the dependent variables of the other entries.

We have tried to follow as literally as possible the indexing scheme just described. For example, tables giving mean salaries of different types of people are indexed under $0, not ME; ages are under Misc., though *age distributions* are under ME; a plot of words per year in journals is Misc., not P. But in many cases, hasty and rather arbitrary decisions had to be made, of which we shall try to list some of the most conspicuous. Data on number of people *changing* between one employment or specialty and another between two given years are usually identified by a 1 in the "Time" column, as they approximate the value of a time derivative evaluated at one time. Data on degrees granted have been assigned to the ME category not the MS. The identification of interdisciplinary areas may not always have been consistent: an area whose physics component is only one of our subfields (e.g., E&PP) may have components belonging to two or three major disciplines, and if these are separated in a table, a 2 or an X in the discipline column is appropriate, even though there is a 1 in the subdiscipline column. Even fuzzier is the situation with regard to commercial products, etc.: often these have been associated regularly with a nonphysics discipline (e.g., electrical engineering) to justify a 1 in the "Discipline" column. Data referring in one sense to one value of an independent variable but in another sense to two or more values (e.g., scientists working in the U.S. but classified according to country of origin) are usually given a 2 or an X in the relevant column.

The arrangement of the index is as follows: Each of the Tables V.1 to V.10 is devoted to a particular one of the dependent variables and in some cases to the combination U.S. physics, of the geographical and discipline variables, or to the remaining combinations (including the combination of U.S. with any other discipline or with a multiplicity of disciplines in which physics might be included). Within each of the tables, the entries are arranged in the order of the entries in the first column—X, 2, 1 (or U.S. or P, when appropriate), no entry—and under each of these in the order of entries in the second column. Further ordering is not by entries in the other columns but is sequential through the four volumes of *Physics in Perspective*. The tables are

Table V.1	Manpower (Employable)—U.S., Physics
Table V.2	Manpower (Employable)—Other Than (U.S., Physics)
Table V.3	Manpower (Students)
Table V.4	Funding—U.S., Physics
Table V.5	Funding—Other Than (U.S., Physics)
Table V.6	Other Money
Table V.7	Publications—U.S., Physics
Table V.8	Publications—Other Than (U.S., Physics)
Table V.9	Miscellaneous—U.S., Physics
Table V.10	Miscellaneous—Other Than (U.S., Physics)

TABLE V.1 Manpower (Employable)—U.S. Physics

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
X	X	1				1	R	Institutional distrib.	I:F4.8	
X	X	1				X	R	Emp. patterns	I:T12.9	
X	X	1				X	R	Emp. patterns	I:T12.10	
X	X	2				1	R	Emp. patterns	I:T12.13	
X	X	1				X	R	Emp. patterns	IIC:TII.12	
X	X	1				1	R	Nonacad. emp.	IIC:TII.2	
X	X	1				1	R	Types of insts.	IIC:TII.47	
X	X					1	R	Distrib. of emp.	IIC:TII.48	
X	2	1				1	R	Subfield distrib.	IIC:TII.14	
X	2	1				1	R	Gov & Industry	IIC:FII.7	
X	2	1	2			1	R	Students & PhD's	IIC:TII.24	
X	1					2	R	Univ. emp.	I:T12.12	
X	1					1	Quest.	Univ. sample	IIC:TIII.21	$F
X						1	R	Program elements	I:App.4A	$F
X		1				2	R	Migration	I:T4.B1	
X		1				2	R	Migration, pl. phys.	I:F4.B.1	
X		1				2	R	Migration, NP	I:F4.B.2	
X		1				2	R	Migration, EP	I:F4.B.3	
X		1				2	R	Migration, AME	I:F4.B.4	
X		1				2	R	Migration, CM	I:F4.B.5	
X		1				2	R	Migration, A&R	I:F4.B.6	
X		1				2	R	Migration, Opt.	I:F4.B.7	
X		1				2	R	Migration, Ph. in Biol.	I:F4.B.8	
X		1				2	R	Migration, Acoust.	I:F4.B.9	
X		1				2	R	Migration, E&PP	I:F4.B.10	
X		1				2	R	Migration, Pl.&Fl	I:F4.B.11	

TABLE V.1 Manpower (Employable)--U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
X						1	R	Subfield distrib.	I:F4.2	
X		2				1	R	Subfield distrib.	I:F4.3	
X				X		1	R	Work activities	I:F4.7	
X		1				1	R	Foreign born	I:T8.10	Misc.
X			X			1	R	Foreign born	I:F8.9	
X		2				1	R	Subfield distrib.	IIA:TII.27	
X						2		NP projections	IIA:TII.23	$F,Misc.
X						2		NP projections	IIA:TII.24	$F,Misc.
X						2		NP projections	IIA:TII.25	$F,Misc.
X						1	R	Comp. of subfields	IIA:TIII.4	
X		2				1	R	Acoust. vs other	IIA:FVI.1	
X						1	R	E&PP field mobility	IIP:TIX.3	
X		2				1	R	E&PP etc.	IIB:TIX.5	
X						X		Authors per paper	IIB:FXIV.34) I:F13.20)	Misc.
X		1				X	R	Birth & citizenship	IIC:TII.10	
X		1				1	R	Noncitizens	IIC:TII.10	
X		1			X	1	R	Federal support	IIC:TII.18	
X		1				1	R	Transition matrix	IIC:TII.25	
X		1	X			2	R	Ages	IIC:TII.26	
X		1	2			2	R	Youth vs mature	IIC:FII.4	
X		1				1	R	Opt. changes	IIC:TII.27	
X		1				1	R	Transition matrix	IIC:TII.28	Misc.
X		1				1	R	Subfield mobility	IIC:TII.29	
X		1				1	R	Competence vs emp.	IIC:TII.35	
X		1				1	R	Extern. competence	IIC:TII.36	

TABLE V.1 Manpower (Employable)—U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
X		1				1	R	Mob. & competence	IIC:FII.6	
X		1				1	R	Subfield distrib.	IIC:TII.41	MS
X		1				1	R	Self-identification	IIC:TII.46	
X		2				1	R	E&PP self-identification	IIC:TII.70	
X		1				1	R	Add. competence E&PP	IIC:TII.71	
X		2				1	R	Competence overlap	IIC:TII.74	
X						1	R	E&PP mobility	IIC:TII.76	
X						1	R	Subfield mobility	IIC:TII.77	
X						1	R	Subfield mobility	IIC:TII.78	
X		1				1	R	E&PP mobility	IIC:TII.79	
X		1				1	R	Mobility vs overlap	IIC:TII.80	
2	X			X		1	R	NP vs total physicists	IIA:TII.26	
2	X	2				1	R	AME physicists	IIA:TIII.2	
2	X	2				1	R	Emps. of opt. scientists	IIA:TV.1	
2	X	2				1	R	Acoust. vs all physics	IIA:FVI.2	
2	X	2				1	R	E&PP emp. patterns	IIB:TIX.6	
2	X					1	R	Ph. in Biol.	IIB:TXI.1	
2		1		X		1	R	NP vs total physicists	IIA:FII.19	
2						1	R	AME physics	IIA.FIII.5	$F,P
2		2				1	R	AME population	IIA:TIII.1	
2				X		1	R	AME physicists	IIA:TIII.3	
2		2		X		1	R	Opt. scientists	IIA:TV.2	
2				X		1	R	Acoust. vs all physics	IIA:FVI.3	
2				X		1	R	Acoust. vs all physics	IIA:TVI.3	
2				X		1	R	Ph. in Biol.	IIB:TXI.2	
2						X	Rec.	Meeting attendance	IIB:FXIV.48	

TABLE V.1 Manpower (Employable)—U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
1	X	1				X	R	E&PP	I:F4.17	$F
1	X					X	R	NP	I:F4.29	
1	X					X	R	AME	I:F4.39	$F
1	X					X	R	CM	I:F4.45	$F
1	X					X	R	Opt.	I:F4.52	$F
1	X					X	R	Acoust.	I:F4.61	$F
1	X					X	R	Pl.&Fl.	I:F4.70	$F
1	X	X				1	Rec.	EP manpower	IIA:TI.3	
1	X	2			1	X	Rec.	AEC program in EP	IIA:TI.7	
1	X					2	Quest.	Univs. granting NP PhD	IIA:TII.30	
1	X					1	R	Acoust. subdivisions	IIA:TVI.4	
1	X					2	R	E&PP mobility	IIC:TII.81	Misc.
1	X	1				2	R	E&PP emp. shifts	IIC:TII.83	
1	2	1				1	R	E&PP emp. shifts	IIC:TII.83	
1						1	R	A&R	I:F4.78	$F
1						1	R	EP	I:F4.18	$F
1						1	R	NP	I:F4.30	$F
1						1	R	AME	I:F4.40	$F
1						1	R	CM	I:F4.46	$F
1						1	R	Opt.	I:F4.53	$F
1						1	R	Acoust.	I:F4.62	$F
1						1	R	Pl.&Fl.	I:F4.71	$F
1						X	Quest. & Ag.	NP in U.S.	IIA:TII.9	
1				X		1	Quest. & Ag.	Univ. manpower NP	IIA:TII.11	$F

TABLE V.1 Manpower (Employable)—U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
1						1		NP projects	IIA:TII.14	$F,Misc.
1						2		New NP facilities	IIA:TII.15	$F
1						1	Ag.	NP projects	IIA:TII.16	$F,Misc.
1						2		NP projections	IIA:TII.17	$F,Misc.
1						2		NP projections	IIA:TII.18	$F,Misc.
1						2		NP projections	IIA:TII.19	$F,Misc.
1						2		NP projections	IIA:TII.20	$F,Misc.
1						2		NP projections	IIA:TII.21	$F,Misc.
1						2		NP projections	IIA:TII.22	$F,Misc.
1		2	X				R	NP physicists	IIA:FII.20	
1						1	R	Acoust. subdivisions	IIA:TVI.6	P
1						X	Ag.	Controlled Thermonuc.	IIA:FVII.1	
1		2				1	R	A&R manpower	IIB:TVIII.1	
1						X	R & Rec.	Growth of acoust.	II[illegible].2	
1		2				1	R	A&R subspecialties	II[illegible].45	
1				X		1	R	E&PP	IIC:[illegible].12	
1		1	X			2	R	Age distrib. E&PP	IIC:TII.75	
1		1				1	R	E&PP mobility	IIC:TII.79	
1		1				1	R	E&PP mobility	IIC:TII.82	
	X					1	R	Institutional distrib.	I:F4.4	
	X	2				1	R	Institutional distrib.	I:F4.5	
	X		X			1	R	Age profiles	I:F9.2	
	X	X				2	Quest.	Rank structure	I:T9.5	
	X	X				1	Quest.	Age-rank structure	I:F9.9	Misc.
	X	1				2	Rec.	List of univs.	I:App9A	
	X					1		Phys. teachers	I:T11.1	$F,$O

TABLE V.1 Manpower (Employable)—U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
	X	1				X	R	Emp. patterns	I:T12.11	
	X	2				X	R	Median ages	I:T12.14	Misc.
	X	2		X		1	R	Manag. responsibilities	I:T12.15	
	X	1				2	R,Quest.	Flux of emp.	I:F12.19	
	X	1		X		1		New & replacement emp.	I:T12.19	
	X	1				2		New employment	I:T12.26	
	X					1		Physics teachers	IIB:TXIII.1	$F,$O, Misc.
	X	X				1	Quest.	Educ. & emp. pipeline	IIB:FXIII.5	Misc.
	X	1				2	R	Emp. distrib.	IIC:TII.13	
	X	1			1	1	R	Federal support	IIC:TII.15	
	X	1		X		1	R	Activities nonacad.	IIC:FII.2	
	X	1		X		1	R	Distrib. of activities	IIC:TII.21	
	X	1		X		1	R	Age & activities	IIC:TII.23	Misc.
	X	1	1			1	R	Subfield mobility	IIC:TII.34	
	X	2				1		Labor force	IIC:TII.37	
	X	1				1	R	Labor force	IIC:TII.38	
	[illegible]	2				1	R	Emp. by sector	IIC:TII.39	
	[illegible]	2		X		1	R	Work activities	IIC:TII.42	
	X					1	Quest.	Univ. sample	IIC:TIII.20	$F,MS, P,Misc.
			X			1	R	BNL & ORNL	I:F9.3	
	2	1				X	R	Emp. trends	I:F12.12	
	2	1				X		First emp.	I:F12.15	
	2	1		2		X		Emp. projections	I:F12.21	
	1		X			[illegible]	R	National labs.	I:F9.4	

TABLE V.1 Manpower (Employable)—U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
	1	X				2	R	Age vs rank	I:F9.8	Misc.
	1	1	X	X		1	R	Academic insts.	I:F9.10	$0
	1	1	X	X		1	R	Nonacademic insts.	I:F9.11	$0
	1	2				1	R	Teachers vs others	I:T11.2	$0,$F
	1	2				X	R,other	Industry & business	I:T12.16	
	1	1	1			X		Educ. insts.	I:F12.14	
	1	1	2			1		Nonacad. em. proj.	I:T12.24	
	1	1		X		X	R	Ind. physicists	I:F12.24	
	1	1		X		X	R	Govt. physicists	I:F12.25	
	1	X				X	Quest,R	ASM vs AIP	IIC:TII.1	
	1					X	Quest,R	ASN vs BLS	IIC:TII.3	
	1	1		X		1	R	Distrib. of activities	IIC:TII.19	
	1	1		X		1	R	Distrib. of activities	IIC:TII.20	
	1	1		X		X	R	Res. vs teaching	IIC:TII.22	
	1	2		X		1	R	Activity distrib.	IIC:FII.8	
	1	2		1		1	R	Development	IIC:TII.43	
	1	2		X		1	R	R&D vs non-R&D	IIC:TII.44	
		1				2	Quest.	PhD's granted	I:F9.A.1	
		X				1		Manpower flow	I:F12.5	MS
		X				X		Freshmen thru faculty	I:T12.1	MS
						X	Rec.	AIP placement reg.	I:F12.18	Misc.
		1				X	R	Unemployment	I:F12.20	
		1				X		Emp. projections	I:T12.27	
		1				X		Prod. projections	I:T12.28	
		1				X		Grads. & enrollments	I:F12.26	MS
		1				X		PhD projections	I:T12.29	

TABLE V.1 Manpower (Employable)—U.S. Physics (cont.)

Sub-discipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
		1				1		Prod. & use projections	I:T12.30	
		2		X		1	R	E&PP etc.	IIB:TIX.7	
		X				1	Quest.	Teacher backgrounds	IIB:FXIII.3	
		2	X			1	R	Age distrib.	IIC:TII.6	
		1				1	R	Birth & citizenship	IIC:TII.8	
		1			X	1	R	Federal support	IIC:TII.16	
		1	2			1	R	Subfield mobility	IIC:TII.30	
		1	1			1	R	Subfield mobility	IIC:TII.31	
		1	X			1	R	Subfield mobility	IIC:TII.32	
		1	X			2	R	Subfield mobility	IIC:TII.33	
		1				1	R	Competence vs emp.	IIC:FII.5	
		2				1	R	Educ. mobility	IIC:TII.40	MS
		2			2	1	R	Govt. support	IIC:TIII.7	
		2			X	1	R	Govt. support sources	IIC:TIII.8	
					X	1	R	Support sources	IIC:FIII.1	P

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TABLE V.2 Manpower (Employable—Other than (U.S., Physics)
(No tables in this category have a breakdown by age.)

Geographic	Discipline	Subdiscipline	Institution (or Type)	Degree or Rank	Activity	Support Source	Time	Source	Remarks	Item	Cross Entries
X	P						X		Citizenship	I:T8.8	Misc.
X	P						1	A&I	Distrib. of authors	IIC:TIV.6	
X	1			1			1		Postdoctorals	I:T8.5	
X							1		Sci. & eng./pop.	I:F8.1	$F
X							1		Sci. & eng.	I:T8.2	P
X							1	A&I,other	Authors	I:F8.4	
X							1	A&I,other	Sci. & eng./GNP	I:F8.5	
2	P			1	?		1		Postdoc. plans	I:T8.6	
2	P			1			1	R	Country of PhD	I:T8.9	
2	P		X	1			1		Emp. destinations	I:T8.11	
2	P	1					X		Controlled thermonuc.	IIA:FVII.2	
2	P			1			1	R	Destinations	IIC:TII.11	
2	P						1	A&I	Prolificness function	IIC:TIV.8	Misc.
2							X		Sci. & eng.	I:F8.7	
US	X			1			1		Citizenship	I:T8.6	
US	X		1				1	Quest.	Sci. teachers	I:F11.4	
US	X		1				2	Quest.	Phys. teachers	I:F11.5	
US	X						X	Rec.	Women doctorates	I:T12.7	
US	X			1			X	Quest.	PhD's & postdocs	I:T12.8	
US	X			2			X		Faculty projections	I:T12.22	
US	X						2		Emp. trends	I:T12.25	
US	X	1		1			1	R	A&R, field of PhD	IIB:TVIII.3	
US	X			1			2	Int.	E&PP undergrad. majors	IIB:TIX.2	
US	X	X		2			1	R	E&PP, etc.	IIB:TIX.5	
US	X	X		1			1	R	Self-identification	IIC:TII.46	
US	X	X					1	R	E&PP	IIC:FII.11	
US	X						1	Quest.	Fields of work & degree	IIC:TII.60	
US	X						1	Quest.	Soc. membership	IIC:TII.61	
US	X	X	X	1			1	R	Environ. sci.	IIC:TII.63	
US	X		1		2		1	R	E&PP, educ. insts.	IIC:TII.65	
US	X						1		Self-identification	IIC:TIV.7	
US	2			1	2		1		Postdoc. plans	I:T8.7	
US	2		X				1	Rec.	Major ind. labs.	I:T9.2	
US	2			1			X	Quest.	Award of doctorates	I:F12.1	
US	2			1			X	R	Male bachelors	I:F12.7	
US	2			2			X	Rec,other	Degree recipients	I:F12.8	
US	2		2	1	2	2		R	Res. activ. & support	I:T12.17	
US	2	X		1			X	Quest.	PhD's granted NP etc.	IIA:TII.29	
US	2	1		1			X	Rec.	Atmos. postdocs.	IIB:TIX.8	
US	2	X					1	R	Phys. chem. specialties	IIB:TX.1	
US	2	X	X	1			1	R	Phys. astron. insts.	IIC:TII.47	
US	2	X		1			1	R	Phys. & astron.	IIC:FII.9	
US	2	2		1			1	R	Employer distrib.	IIC:TII.48	
US	2		1	1			1	R	Univ. activities	IIC:TII.49	
US	2	2		X			1	R	Academic rank	IIC:TII.50	
US	2	2		1			1	R	Theory vs expt.	IIC:TII.51	
US	2	2		2			1	R	Degree level	IIC:TII.52	
US	2	2		1			1	R	Field of degree	IIC:TII.55	
US	2	2		1			1	R	Additional competence	IIC:TII.56	
US	2	2					X	R	Growth of A&R	IIC:TII.57	
US	2	2			1		1	R	Mobility A&R, E&PP	IIC:TII.58	
US	2	X		1			1	R	A&R mobility	IIC:FII.10	
US	2		X	2			1	R	E&PP	IIC:TII.90	
US	2	X	1	X			1	R	Faculty, E&PP	IIC:TII.64	
US	2	X		X			1	Quest.	Degree prod.	IIC:TII.66	
US	2			1			1	R	PhD prod. & utiliz.	IIC:TII.67	
US	2			2	X		1	R	Environ. scientists	IIC:TII.68	
US	2	2	X	2	1		1	R	Environ. scientists	IIC:TII.69	
US	2	2	1		X		1	R	E&PP	IIC:TII.70	
US	2		1	2			X	Quest.	Ind. manpower	IIC:TIII.16	
US	1	2	X	2			1	R	CM exp.	IIA:TIV.8	
US	1	2		2	X		1	R	CM vs all phys.	IIA:TIV.9	
US	1	X		1			1	R	Astron. manpower	IIB:TVIII.2	
US	1			X			X		Geosci. projections	IIB:FIX.17	
US	1		X	X			1		Geoscientists	IIB:FIX.18	
US	1				X		1	R	Geoscientists	IIC:FII.13	
US			X				1		Full profs.	I:T9.6	
US							X		Unemployment	I:F12.4	
US							X		Faculty projections	I:T12.21	
US							X		GNP factors	I:T12.23A	$D,Misc.
US							X		Civilian emp.	I:T12.23D	
US		2		1	X		2	Quest.	NP mobility	IIA:TII.28	
US				X			1	Quest.	Teacher backgrounds	IIB:FXIII.2	
US				X			1	Quest.	Students & teachers	IIB:FXIII.4	MS
	P						1	A&I	Papers per author	IIC:FIV.1	
			1				1	Quest.	Time distrib.	IIB:FXIV.6	

TABLE V.2 Manpower (Students)—U.S.
(None of the reports give data on students outside the U.S.

Disci-pline	Sub-disci-pline	Insti-tution (or Type)	Degree or Level	Support Source	Time	Source	Remarks	Item	Cross Entries
X					X		H.S. enrollments	I:F11.3	
X					1	Quest.	Career choices	I:T12.2	
X					X	Quest.	Choices of major	I:F12.6	
X			1		X		H.S. sci. enrollments	IIB:FXIII.1	
P	X		1		1		Students & PhD's	IIC:TII.24	ME
P	X				1	R	Subfield distrib.	IIC:TII.41	ME
P		X	X		1		Manpower flow	I:F12.5	ME
P			X		X		Freshman thru faculty	I:T12.1	ME
P			1		X		% entering grad. sch.	I:F12.9	
P				X	1	Quest.	Student support	I:T12.5	
P					1	Quest.	Citizenship & sex	I:T12.6	
P			2		X		Grads. & enrollments	I:F12.26	ME
P		X	X		1	Quest.	Educ. & emp. pipeline	IIB:FXIII.5	ME
P					1	R	Educ. mobility	IIC:TII.40	ME,Misc.
P		X	2		1	Quest.	Univ. sample	IIC:TIII.20	$F,ME,P,) Misc.)
				1	X		Fed. support	I:F12.10	$F
					2		Grad. stipends	I:T12.4	
			X		X		Projections of pop.	I:T12.20	
					X		Projections of pop.	I:F12.22	
					X		Enrollment projections	I:T12.21	
			X		1		Students & teachers	IIB:FXIII.4	ME

TABLE V.4 Funding—U.S., Physics

Sub-discipline	Institution (or Type)	Support Source	Time	Source	Remarks	Item	Cross Entries
X	1		1	Quest.	Univ. Sample	II:TIII.21	ME
X			1		Program elements	I:App.4A	
X			X	Ag.	Basic phys. funds	I:F5.2	
X		2	1	Ag,other	Fed. & ind. funding	I:T5.2	
X			X	Quest.	Biophys. facilities	I:T9.8	SO
X		1	X	Ag.	AEC	I:F10.4	
X		1	X	Ag.	NSF	I:F10.5	
X		1	X	Ag.	DOD	I:F10.6	
X		1	1	Ag.	ARO	I:T10.A.12	
X		1	1	Ag.	NBS	I:T10.A.18	
X			2		NP projections	IIA:TII.23	ME,Misc.
X			2		NP projections	IIA:TII.24	ME,Misc.
X			2		NP projections	IIA:TII.25	ME,Misc.
X		X	X	Ag.	Ag. expenditures	IIC:TIII.9	
X		X	X	Ag.	DOD expenditures	IIC:TIII.10	
X		X	1	Ag.	NASA support	IIC:TIII.14	
X		1	1	Ag.	NBS expenditures	IIC:TIII.15	
X		X	1	Ag.	Funding distrib.	IIC:FIII.2	P
2			1	Ag.	AME physics	IIA:FIII.5	ME,P
2		X	1	Quest,Ag.	CM vs all physics	IIA:TIV.1	
1	X		X	Ag.	EP expenditures	IIA:TI.6	
1	X		X		EP cost projections	IIA:TI.10	
1	X		X		EP cost projections	IIA:TI.11	
1	X		X		EP cost projections	IIA:TI.12	
1	X		X		EP cost projections	IIA:TI.13	
1	X		X	Ag.	EP expenditures	IIA:FI.21	
1	X		X		EP cost projections	IIA:FI.23	
1	X		X		EP cost projections	IIA:FI.24	

TABLE V.4 Funding—U.S., Physics (cont.)

Sub-discipline	Institution (or Type)	Support Source	Time	Source	Remarks	Item	Cross Entries
1	X		X		EP cost projections	IIA:FI.25	
1	X		X		EP cost projections	IIA:FI.26	
1	X		X	Ag.	NP costs	IIA:FII.18	
1			X	Ag.	EP	I:F4.17	ME
1			1	Ag.	EP	I:F4.18	ME
1			X	Ag.	NP	I:F4.29	ME
1		2	1	Ag.	NP	I:F4.30	ME
1			X	Ag.	AME	I:F4.39	ME
1		2	1	Ag.	AME	I:F4.40	ME
1			X	Ag.	CM	I:F4.45	ME
1		2	1	Ag.	CM	I:F4.46	ME
1			1	Ag.	Opt.	I:F4.52	ME
1		2	1	Ag.	Opt.	I:F4.53	ME
1			X	Ag.	Acoust.	I:F4.61	ME
1		2	1	Ag.	Acoust.	I:F4.62	ME
1			I	Ag.	Pl.&Fl.	I:F4.70	ME
1		2	1	Ag.	Pl.&Fl.	I:F4.71	ME
1		2	1	Ag.	A&R	I:F4.78	ME
1			X	Rec.	LAMPF	I:F5.17	$0
1			X	Rec.	NAL	I:F5.18	$0
1			X	Ag.	EP expenditures	IIA:FI.22	
1			X	Ag.	NP support	IIA:FII.17	$0
1			X	Quest.,Ag.	NP funding	IIA:TII.9	
1			1	Quest.,Ag.	Univ. funding NP	IIA:TII.11	ME
1			1		Univ. NP projects	IIA:TII.12	Misc.
1			1		Natl. lab. NP projects	IIA:TII.13	Misc.
1			1		NP projects	IIA:TII.14	ME,Misc.
1			2		New NP facilities	IIA:TII.15	ME

TABLE V.4 Funding—U.S., Physics (cont.)

Sub-discipline	Institution (or Type)	Support Source	Time	Source	Remarks	Item	Cross Entries
1			1	Ag.	NP projects	IIA:TII.16	ME,Misc.
1			2		NP projections	IIA:TII.17	ME,Misc.
1			2		NP projections	IIA:TII.18	ME,Misc.
1			2		NP projections	IIA:TII.19	ME,Misc.
1			2		NP projections	IIA:TII.20	ME,Misc.
1			2		NP projections	IIA:TII.21	ME,Misc.
1			2		NP projections	IIA:TII.22	ME,Misc.
1		X	X	Ag.	AME	IIA:FIII.4	
1		1	1	Ag.	NSF proposals AME	IIA:FIII.7	Misc.
1		1	1	Ag.	NSF proposals AME	IIA:FIII.8	Misc.
1			X		Underwater & geoacoust.	IIA:TVI.2	
1		X	X	Ag.	Acoust.	IIA:FVI.4	
1		X	1		Acoust. subdivisions	IIA:TVI.4	ME
1			X		Projections AC areas	IIA:FVI.5	
1		X	X	Ag.	AME & Pl. support	IIA:FVII.3	
1		X	1		Phys. of Fl.	IIA:sec.VII8.2	
1			1	Ag.	A&R funding	IIB:TVIII.4	
1		1	X	Ag.	NASA space phys.	IIB:FIX.19	
	X	1	X	Ag.	AEC labs.	I:F9.15	
	X		1		Teaching expenditures	IIB:TXIII.1	ME,$O,Misc.
	X		1	Quest.	Ind. public & support	IIC:TIII.19	P
	X		1	Quest.	Univ. sample	IIC:TIII.20	ME,MS,P,Misc.
	1		1	R	Salary costs	I:T11.2	ME,$O
	1	2	X	Quest.	Ind. funding	IIC:TIII.17	
	1	1	1	Quest.	Univ. salary support	IIC:TIII.22	
			X	Ag.	Federal support	I:F1.1	
			X	Ag.	Federal support	I:F5.16	

TABLE V.4 Funding—U.S., Physics (cont.)

Sub-discipline	Institution (or Type)	Support Source	Time	Source	Remarks	Item	Cross Entries
		X	X	Ag.	Basic phys.	I.F10.3	
		1	X	Ag.	Physics/total budget	I:F10.7	
		1	1	Ag.	NASA	I:T10.A.14	
			1		Teaching phys.	I:T11.1	ME,$0
		X	1	Ag.	Salary costs	I:T11.3	
		X	X	Ag.	Educ. expenditures	I:F11.6	
		X	1	Ag.	Federal res. obligs.	IIB:TXIII.3	
			1	Rec.,other	Info. services	IIB:FXIV.9) I:F13.5)	
		X	1	Ag.	Federal obligs.	IIC:TII.17	
		1	X	Ag.	IDL support	IIC:TIII.11	

TABLE V.5 Funding—Other than (U.S., Physics)

Geographic	Discipline	Sub-discipline	Support Source	Time	Source	Remarks	Item	Cross Entries
X				1		R&D/GNP	I:F8.1	ME
X				X		R&D	I:F8.2	
X				2		R&D	I:F8.3	
X				1		Know-how sales	I:F8.6	$0
U.S.	X	X	1	X	Ag.	AEC labs	I:F9.16	
U.S.	X		X	1	Ag.	Ag. distrib.	I:T10.A.1	
U.S.	X		X	1	Ag.	Ag. distrib.	I:T10.A.2	
U.S.	X		X	1	Ag.	Ag. distrib.	I:T10.A.3	
U.S.	X		X	1	Ag.	Ag. distrib.	I:T10.A.4	
U.S.	X	X	1	X	Ag.	AEC	I:T10.A.6	
U.S.	X		1	X	Ag.	DOD	I:T10.A.10	
U.S.	X		1	2	Ag.	Air Force	I:T10.A.11	
U.S.	X		X	1	Ag.	Dept. of Agric.	I:T10.A.15	
U.S.	X		2	1	Ag.	Commerce	I:T10.A.17	
U.S.	X	X	X	X	Ag.	NP funding	IIA:TII.10	
U.S.	X	1	X	1	Ag.	Plasma support	IIA:pp.725-6	Misc.
U.S.	X			X	Ag.	Environ. Sci.	IIB:TIX.12	
U.S.	X			1	Ag.	Environ. Sci.	IIB:FIX.14	
U.S.	X		X	1	Ag.	Environ. Sci.	IIB:TIX.11	
U.S.	X		1	X	Ag.	OSSA budget	IIB:TIX.20	
U.S.	2		X	X	Ag.	Phys. & Environ. Sci.	I:F5.1	
U.S.	2	X	1	X	Ag.	NSF	I:T10A.8	
U.S.	2					A&R recommendations	IIB:TVIII.5	
U.S.	2	1				A&R recommendations	IIB:TVIII.6	
U.S.	2		X	1	Ag.	R&D obligs.	IIB:TIX.10	
U.S.	1	X	1	X	Ag.	NSF atmos. sci.	IIB:TIX.13	
U.S.	1	X		X		Atmos. sci.	IIB:FIX.15	
U.S.	1			X		NCAR appropriations	IIB:FIX.16	

TABLE V.5 Funding—Other than (U.S., Physics) (cont.)

Geo-graphic	Discipline	Sub-discipline	Support Source	Time	Source	Remarks	Item	Cross Entries
U.S.	1		1	X	Ag.	NSF atmos. sci.	IIB:TIX.14	
U.S.	1			1		CAS recommendations	IIB:TIX.15	
U.S.	1	X	1	X	Ag.	NSF geosci.	IIB:TIX.16	
U.S.	1	1	1	X	Ag.	NSF geophys.	IIB:TIX.17	
U.S.	1		1	X	Ag.	NSF oceanog.	IIB:TIX.18	
U.S.	1		1		Ag.	OSSA typical	IIB:TIX.19	
U.S.			2	X	Surveys	R&D etc.	I:F10.1	
U.S.			X	X	Ag.	Basic res.	I:F10.2	
U.S.			X	X	Ag.	Ag. distrib.	I:T10.A.5	
U.S.			1	X	Ag.	NSF	I:T10.A.7	
U.S.			2	X	Ag.	DOD vs NSF	I:T10.A.9	
U.S.			1	X	Ag.	Navy	I:T10.A.13	
U.S.			1	2	Ag.	NIH	I:T10.A.16	
U.S.			2	1	Ag.	Interior	I:T10.A.19	
U.S.				X		R&D	I:F12.2	
U.S.				X		Ind. R&D	I:F12.3	
U.S.			1	X		Fed. support & GNP	I:F12.10	MS
U.S.			2	X		Sources of R&D funds	I:F12.11	
U.S.				X		Basic res.	I:F12.13	
U.S.			2	X		Basic res. vs all R&D	I:T12,18	
U.S.				1		Accelerators	IIA:TII.2	Misc.

TABLE V.6 Other Money

Geographic	Discipline	Subdiscipline	Institution (or Type)	Degree or Rank	Age or Exp.	Activity	Time	Source	Remarks	Item	Cross Entries
X	X						1		Exports & imports	I:F7.4	
X	I						1		Electronic trade	IIA:TIV.7	
X							X		Wages	I:F4.106	
X							X		Prices	I:F4.107	
X							X		Mfg. output	I:F4.108	
X							X		Labor costs	I:F4.109	
X							1		GNP	I:T7.2	
X							1		GNP & energy	I:F7.10	Misc.
X							1		Relative R&D costs	I:T8.1	
X							1		Know-how sales	I:F8.6	$F
X							X		Wage payments	IIB:FXII.1	
X							X		Consumer prices	IIB:FXII.2	
X							X		Man-hour productivity	IIB:FXII.3	
X							X		Unit labor costs	IIB:FXII.4	
U.S.	X						X		U.S. trade	I:T7.3	
U.S.	X						X		U.S. trade	I:F7.3	
U.S.	X						1	Rec.	Prerun costs	IIB:FXIV.21	
U.S.	X		2				1	Ag.	Cost increase	IIC:TIII.23	
U.S.	P	X					1		Costs/man-yr.	I:T5.1	
U.S.	P	X	X				X	Ag.	AEC costs	IIC:FIII.12	
U.S.	P	1					X	Rec.	LAMPF	I:F5.17	$F
U.S.	P	1					X	Rec.	NAL	I:F5.18	$F
U.S.	P		1	1	X		1	R	Academic insts.	I:F9.10	ME
U.S.	P		1	1	X		1	R	Nonacademic insts.	I:F9.11	ME
U.S.	P		X	1	1		1	R	Salaries	I:F9.12	
U.S.	P		1	1	1	X	1	R	Salaries	I:F9.13	
U.S.	P		1	1	1	X	1	R	Salaries	I:F9.14	

TABLE V.6 Other Money (cont.)

Geo-graphic	Disci-pline	Sub-disci-pline	Insti-tution (or Type)	Degree or Rank	Age or Exp.	Activity	Time	Source	Remarks	Item	Cross Entries
U.S.	P	X					X	Quest.	Biophys. facilities	I:T9.8	$F
U.S.	P		1	2			1	R	Teacher salaries	I:T11.1	$F,ME
U.S.	P		1	2			1	R	Salaries	I:T11.1	ME,$F
U.S.	P	1	X				1		New accelerators	IIA:TII.8	Misc.
U.S.	F		X				1		Teacher salaries	IIB:TXIII.1	ME,$F, Misc.
U.S.	P		2	2			1	R	Salaries	IIB:TXIII.2	
U.S.			1				X		Cost/scientist	I:F9.1	
U.S.							X		GNP factors	I:T12.23A	Misc,ME
U.S.							X		GNP components	I:T12.23B	
U.S.							X		GNP	IIA:FII.17	$F
U.S.							X	Rec.	Semicond. sales	IIA:FIV.2	
U.S.							X		Magnetics sales	IIA:FIV.3	
U.S.							X		Electronic purchases	IIA:FIV.4	
U.S.							1		Semicond. sales	IIA:TIV.2	
U.S.							1		Unit costs of teaching	IIB:TXIII.4	
U.S.							1	Rec.	Runoff costs	IIB:FXIV.22	
	P						X		NMR equipment	I:F4.101	
	P	1					1		Types of accelerators	IIA:TII.4	Misc.
	P						X	Rec.	Phys. Abstr. price	IIB:FXIV.14	Misc.
	P						1	Rec. & J.	Journal prices & costs	IIB:FXIV.24	
	P						1	Lit.	Book prices	IIB:FXIV.44	
	1						X		Core memory	I:F4.111	
	1						X		Minicomputers	I:F4.112	
	1						X		Computer costs	I:F7.2	Misc.
	1	1					X		Core memory costs	IIB:FXII.6	
	1	1					X		Minicomputer costs	IIB:FXII.7	
			X				1		Computer installations	I:F7.1	
									Timekeeping devices	IIB:XIITH.1	
							X		Costs of NMR	IIB:FXI.1	

TABLE V.7 Publications—U.S., Physics

Subdiscipline	Institution	Support Source	Time	Source	Remarks	Item	Cross Entries
X	X		1	A&I	Distribution	I:F4.6	
X	X		X	J.	Phys. Rev.	I:T9.9	
X	X		1	A&I	Exp. & theor. papers	IIA:TIII.5	
X	X		1	A&I	Distrib. of papers	IIB:TXIV.11	
X	X		1	A&I	Papers produced	IIB:FXIV.32) I:F13.18)	
X	X		1	J.	Author affiliations	IIC:TIII.3	
X	X		1	A&I	Performing inst.	IIC:TIV.4	
X	2		1	A&I	Theses	IIC:TIV.9	
X	2		1	A&I	Theses	IIC:TIV.10	
X	1	X	1	J.	Support acknowledgments	IIC:TIII.2	
X			2		Scientific publicity	IIB:FXIV.49) I:F13.29)	
X			X		Age of citations	IIB:FXIV.35) I:F13.21)	
X		X	1	J.	Support acknowledgments	IIC:TIII.1	
X			1	J.	Support acknowledgments	IIC:FIII.2	
X		1	1	J.	Papers supported DOD	IIC:TIII.4	
X		1	1	J.	Papers supported AEC	IIC:TIII.5	
X		1	1	J.	Papers supported NASA	IIC:TIII.6	
X			1	A&I	Distrib. of U.S. papers	IIC:TIV.1	
X			1	A&I	Distrib. of U.S. papers	IIC:TIV.2	
2			1	A&I	AME physics	IIA:FIII.5	$F,ME
2			X	J.	Age of cits. in revs.	IIB:FXIV.43) I:F13.25)	
1	X		1	J.	E&PP papers	IIB:TIX.9	
1			X	J.	JASA papers	IIA:TVI.5	
1			1	J.	Acoust. subdivisions	IIA:TVI.6	ME

TABLE V.7 Publications—U.S., Physics (cont.)

Subdiscipline	Institution	Support Source	Time	Source	Remarks	Item	Cross Entries
1			X	J.	Growth of acoust.	IIC:TII.2	ME
	X		1	A&I	Major ind. labs.	I:T9.3	
	X		1	A&I	Types of ind. labs.	I:T9.4	
	X		1	Quest.	Univ. sample	IIC:TIII.20	$F,ME) MS,Misc.)
	X		1	Quest.	Teaching vs rating	IIC:FIII.7	
	X		1	Quest.	Publs. vs rating	IIC:FIII.8	
	X		1	Quest.	Support vs rating	IIC:FIII.9	
	X		1	J.	Size of insts.	IIC:FIII.11	
	1		1	Quest.	Ind. publs. & support	IIC:TIII.19	$F
			1	J.	Journal time lags	IIB:FXIV.25) I:F13.14)	
	1		1	Quest.	Publs. vs teaching	IIC:FIII.5	
	1		1	Quest.	Publs. vs students	IIC:FIII.6	
			1	Eds.	Fate of manuscripts	IIB:FXIV.26	
			X	A&I	Citation statistics	IIB:FXIV.37) I:F13.22)	
		X	1	J.	DOD support	IIC:TIII.12	
		X	1	J.	Support sources	IIC:FIII.1	ME

TABLE V.8 Publications—Other than (Physics, U.S.)

Geo-graphic	Disci-pline	Subdis-cipline	Time	Source	Remarks	Item		Cross Entries
X	P	X	1	A&I	Distrib. by countries	I:T8.3		
X	P	1	2	A&I	CM publ.	IIA:TIV.3		
X	P		1	A&I	Regions work vs publ.	IIB:TXIV.9		
X	P	X	1	A&I	Geog. distrib. of work	IIB:TXIV.10		
X	P	2	1	A&I	Abstr. jrnl. coverage	IIB:FXIV.12		
X	P	X	1	A&I	Papers produced	IIB:FXIV.31	I:F13.17	
X			1	A&I	Authors	I:T8.2		ME
X	P		1	A&I	Region of publ.	IIC:TIV.3		
X	P	1	1	A&I	Geog. distrib.	IIC:TIV.5		
2	2		1	J.	IEEE citations	IIC:TIV.11		
U.S.	X		1	Ag.	DOD categories	IIC:TIII.13		
U.S.	2		1	Quest.	Ind. publ.	IIC:TIII.18		
	X		1	A&I	Citation matrix	IIB:FXIV.29		
	P	X	1	A&I	Papers & theses	IIA:TIII.4		
	P	1	1	Quest.,Int.	Quality of CM papers	IIA:TIV.10		Misc.
	P		X	A&I	Specializ. of jrnls.	IIB:FXIV.28	I:F13.15	Misc.
	P		1	Lit.	Cits. in rev. lit.	IIB:TXIV.14		
	P		X	J.	Age of citation of revs.	IIB:TXIV.15		
	P	1	1	A&I	Cits to rev. lit.	IIB:TXIV.16		
	P			Lit.	Purpose of books	IIB:TXIV.21		
	P	1		A&I	Quality & cits; CM	IIB:FXIV.36		
	P		X	A&I	Rev. articles	IIB:FXIV.39		
	P		X	A&I	Abstr. jrnl. entries	IIB:FXIV.10	I:F13.6	
	P		1	A&I	Abstr. jrnl. entries	IIB:FXIV.11	I:F13.7	
	P		1	A&I	Jrnl. prolificness	IIB:FXIV.13	I:F13.8	
	P		1	A&I	Phys. abstr. entries	IIB:FXIV.17	I:F13.11	
	P		1	J.	Citations from *Phys. Rev.*	IIB:FXIV.30	I:F13.16	

TABLE V.9 Miscellaneous—U.S., Physics

Subdiscipline	Institution (or Type)	Degree or Rank	Support Source	Time	Source	Remarks	Item	Cross Entries
X	1		1	1	Quest.	Salary support	IIC:FIII.10	
X		1		1	R	Foreign-born	I:T8.10	ME
X				2		NP projections	IIA:TII.23	ME,$F
X				2		NP projections	IIA:TII.24	$F,ME
X				2		NP projections	IIA:TII.25	$F,ME
X				X	J	Authors per paper	IIB:FXIV.34 I:F13.20	ME
X				1	R	Specialties vs areas	IIC:TII.4	
X		1		2	R	Median ages	IIC:TII.7	
X		1		1		Transition matrix & age	IIC:TII.25	ME
X		1		1	R	Age distribs.	IIC:TII.28	ME
1	X			X	Rec.	Accelerator utilization	IIA:TI.8	
1	X			1	Rec.	Accelerator capabilities	IIA:TI.9	
1	X			1		Accelerators & reactors	IIA:TII.3	
1	X			1		Census of accelerators	IIA:TII.5	
1	X			1		Census of reactors	IIA:TII.6	
1	X			X		Accelerators shut down	IIA:TII.7	
1	X			1		New accelerators	IIA:TII.8	$O
1	X	1		2	R	E&PP ages	IIC:TII.83	
1				1		Accelerators	IIA:TII.2	$F
1				1		Univ. NP project sizes	IIA:TII.12	$F
1				1		Natl. lab. NP projects	IIA:TII.13	$F
1				1		NP projects	IIA:TII.14	ME,$F
1				1	Ag.	NP projects	IIA:TII.16	$F,ME
1				2		NP projections	IIA:TII.17	$F,ME
1				2		NP projections	IIA:TII.18	$F,ME
1				2		NP projections	IIA:TII.19	$F,ME
1				2		NP projections	IIA:TII.20	$F,ME
1				2		NP projections	IIA:TII.21	$F,ME

TABLE V.9 Miscellaneous—U.S., Physics (cont.)

Subdiscipline	Institution (or Type)	Degree or Rank	Support Source	Time	Source	Remarks	Item	Cross Entries
1				2		NP projections	IIA:TII.22	$F,ME
1			1	1	Ag.	NSF proposals AME	IIA:FIII.7	$F
1			1	1	Ag.	NSF proposals AME	IIA:FIII.8	$F
1				1		Univs. & acoust. specialties	IIA:App.A	
1				1		Govt. labs. acoust.	IIA:App.B	
1		1		2	R	E&PP ages	IIC:TII.81	ME
1		1		1	R	E&PP ages	IIC:TII.82	ME
	X			X		Major labs.	I:T9.1	
	X	X		1	Quest.	Age-rank structure	I:F9.9	ME
	X			1		Quality categories	I:T9.7	
	X	2		X	R	Age vs employment	I:T12.14	
	X			X	Quest.	Numbers of faculties	IIB:FXIII.6	
	X			1		Teacher-time distrib.	IIB:TXIII.1	ME,$F,$O
	X		X	1	Ag.	Info. anal. centers	IIB:TXIV.19	
	X	1		1	R	Age & activities	IIC:TII.23	ME
	X			1	Quest.	Univ. sample	IIC:TIII.20	$F,ME,MS,P
	1	X		2	R	Age vs rank	I:F9.8	ME
	1			1	Quest.	Res. vs teaching	IIC:FIII.3	
	1		1	1	Quest.	Support vs teaching	IIIC:FIII.4	
				X		PhD-granting univs.	I:F9.5	
				2	Rec.	Dept. size	I:F9.6	
				X	Quest.	Phys. faculties	I:F11.2	
				X	J	Empl. ads	I:F12.16	
				X	Rec.	AIP placement	I:F12.18	
				1		Scientific meetings	IIB:TXIV.17	
				X	Rec.	Page charge honoring	IIB:FXIV.23	
				X	J	Length of papers	IIB:FXIV.33 I:F13.19	
		1		1	R	Median ages	IIC:TII.31	ME

TABLE V.10 Miscellaneous—Other than (U.S., Physics)

Geographic	Discipline	Subdiscipline	Institution (or Type)	Support Source	Time	Source	Remarks	Item		Cross Entries
X	X				1		ICSU	I:App.8A		
X	P	1	X		1	Rec.	Accelerators > 1.5 GeV	I:T4.2		
X	P	1			1		Accelerators	I:F8.8		
X	P				1	R	Citizenship & age	I:T8.8		ME
X	P	1	X		1	Rec.	Accelerators > 1.5 GeV	IIA:TI.4		
X	P	1	X		1	Rec.	Storage rings	IIA:TI.5		
X	P	1			1	Rec.	Accelerator & reactor loc.	IIA:FII.7		
X	P				1	A&I	Conc. of jrnls.	IIB:FXIV.27		
X	1				1		GNP & energy	I:F7.10		SO
X	1						Semicond. mfgrs.	IA:TIV.5		
X	1				X		Computer innovations	IIB:TIV.6		
X					1		Accelerator locations	IIA:F2.3		
2	1				1		Energy	I:T7.4		
2	P	2			1	Quest.	Communic. media	IIB:FXIV.5		
1	P				1		Dept. size	I:F9.7		
U.S.	X				1	Quest.	Aptitude scores	I:T12.3		
U.S.	X	1		X	1		Plasma grants	IIA:pp.725-6		
U.S.	X			1			Rec. new starts	IIB:TIX.21		
U.S.	X				1		Data centers	IIB:IXApp.8		
U.S.	P	2	1		1	R	Median ages A&R	IIC:TII.54		
U.S.	1				X		Telecommunications	I:F4.34		
U.S.	1				X		Energy	I:F7.9		
U.S.					1		Univ. fiscal troubles'	I:T6.1		
U.S.					1	Rec.	Committees USC	I:T14.1		
U.S.					X	J	Employment ads	I:F12.17		
U.S.					X		GNP factors	I:T12.23A		SO,ME
U.S.					2		Growth industries	I:T12.23C		
U.S.					1	Ag.	Reactors	IIA:TII.1		
U.S.					X	Ag.	Nuclear power plants	IIA:FII.2		
U.S.					X	Ag.	Info. anal. centers	IIB:FXIV.48	I:F13.28	
	X					Quest.,Int.	Communic. media	IIB:FXIV.4	I:F13.3	
	X				1		Abstr. jrnls. circ.	IIB:FXIV.15	I:F13.10	
	X				1	A&I	Abstr. jrnls.	IIB:FXIV.16		
	X				1	Lit.	Rev. lit.	IIB:FXIV.40		
	2					Quest.Int.	Time in communic.	IIB:FXIV.3	I:F13.3	
	P	1					Plasma expts.	I:F4.65		
	P	X			1		Jury ratings	I:F5.4		
	P	1			1		Jury ratings	I:F5.6		
	P	1			1		Jury ratings	I:F5.7		
	P	1			1		Jury ratings	I:F5.8		
	P	1			1		Jury ratings	I:F5.9		
	P	1			1		Jury ratings	I:F5.10		
	P	1			1		Jury ratings	I:F5.11		
	P	1			1		Jury ratings	I:F5.12		
	P	X			[illegible]		Jury ratings	I:F5.13		
	P	X			[illegible]		Extrinsic vs intrinsic	I:F5.14		
	P	X			1		Extrinsic vs intrinsic	I:F5.15		
	P	X			1		Jury ratings	I:App.5A-5D		
	P	1			1		Types of accelerators	IIA:TII.4		SO
	P	1			1	Quest.Int.	Quality of CM papers	IIA:TIV.10		P
	P				1	Rec.	Rev. jrnls. circ.	IIB:FXIV.45		
	P				1	Lit.	Kinds of rev. lit.	IIB:FXIV.46	I:F13.26	
	P	X			1	A&I	Emphasis in jrnls.	IIB:XIVApp.A		
	P				1		Abstr. & title Jrnls.	IIB:TXIV.1		
	P				1		Abstr. jrnls.	IIB:TXIV.2		
	P				1		Title jrnls.	IIB:TXIV.3		
	P				1		Secondary services	IIB:TXIV.4		
	P				1		Abstr. jrnl. indexes	IIB:TXIV.5		
	P				1		Secondary services	IIB:TXIV.6	I:T13.1	
	1				1		Energy prod.	I:T4.3		
	P				1	J.	Jrnl. time lags	IIB:TXIV.8	I:T13.2	
	P		1		X		Age of jrnls. read	IIB:TXIV.12	I:T13.3	
	P	1			1	Quest.	Oral communication	IIB:TXIV.18		
	P				1	A&I	Interdisc. jrnls.	IIB:TXIV.20		
	P	1	1		1	Int.	Info. transmission	IIB :FXIV.7	I:F13.4	
	P	1			X	Int.	Info. transmission	IIB:FXIV.8		
	P				X	Rec.	Phys. abstr. circ.	IIB:FXIV.14	I:F13.9	SO
	P				1	J.	Jrnl. bulk & price	IIB:FXIV.18		
	P				1	Rec.	Jrnl. circs.	IIB:FXIV.19	I:F13.13	
	P				X	J.	Bulk of jrnls.	IIB:FXIV.20	I:F13.12	
	P				X	A&I	Jrnl. specialization	IIB:FXIV.28	I:F13.15	P
	P				1	Quest,A&I	Rev. lit.	IIB:FXIV.41	I:F13.24	
	P	1			1	A&I	Rev. lit. CM	IIB:FXIV.42		
	1				X		Computer efficiency	I:F7.2		SO
	1		X		X		Semicond. innovations	IIA:TIV.6		
							Discoveries vs exploit.	I:T7.1		
					X		Laser power	IIA:FIV.1		
					X		Computer generations	IIA:FIV.5		
							Timekeeping devices	IIB:XIIITB.1		SO

APPENDIX A: SELECTED TABLES FROM THE PHYSICS PORTION OF THE NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

The next few pages reproduce the 1964, 1968, and 1970 questionnaire forms. After these follow the tables; their content has been described in Section II.1.2. The number following the T in the upper left-hand corner of each table designates the type of table, as labeled in the first column of Table II.4 of the text. The labeling of the rows and columns corresponds to the choices offered on corresponding questions of the National Register form; the numbers in parentheses at the heads of the columns of Table II.4 can be used to locate these on the 1970 form. Each table is given an identifying number at the right.

A variety of abbreviations is used in the tables. Those pertaining to the various subfields are the following:

A&R, Astrophysics and relativity
AME, Atomic, molecular, and electron physics
EP, Elementary-particle physics
NP, Nuclear physics
F, Physics of fluids
P, Plasma physics
P&F, Plasma physics and physics of fluids
CM, Condensed-matter physics
E&P, Earth and planetary physics
BIO, Physics in biology
OPT, Optics

ACOUST, Acoustics
ASTRON, Astronomy (all areas other than astrophysics and relativity)
MISC, Miscellaneous physics

Many of the tables have subrows labeled with N, H, V, and sometimes HP. Here, N is the number of registrants relevant to the given box of the table, H is the percentage that this box comprises of the horizontal total in the table, V is the percentage that this box comprises of the vertical total, and HP is the value of the column variable at the indicated percentage of the horizontal total. For example, in the columns labeled salary ranges, as in Table 12, an entry, 50 = s, in the HP subrow means that s is the median salary for the row in question. A statement, dimension-001 01, means merely that there is no specialization other than that indicated for dimensions 002 and 003.

PLEASE DO NOT WRITE IN THIS COLUMN

NATIONAL REGISTER
OF SCIENTIFIC AND TECHNICAL PERSONNEL

IN THE FIELD OF **PHYSICS AND ASTRONOMY** CONDUCTED BY THE
AMERICAN INSTITUTE OF PHYSICS
335 EAST 45TH STREET, NEW YORK, NEW YORK 10017
AND THE NATIONAL SCIENCE FOUNDATION

And in other fields of science by the American Chemical Society, American Economic Association, American Geological Institute, American Institute of Biological Sciences, American Mathematical Society, American Meteorological Society, American Psychological Association, American Sociological Association, Federation of American Societies for Experimental Biology, and the Center for Applied Linguistics of The Modern Language Association of America.

PLEASE PRINT ANSWERS IN DARK INK OR TYPE

IF YOUR NAME OR ADDRESS AT LEFT IS INCORRECT, PLEASE ENTER CORRECT INFORMATION BELOW. PLEASE GIVE FULL NAME

PLEASE BE SURE YOUR POSTAL ZIP CODE IS INDICATED

NOTE: If you have received and completed a National Register questionnaire from one of the other organizations listed above since March 1, 1966, please write the name of the organization here ______; also, please complete item 1, and on the back of the questionnaire, give your social security number, date and signature, and return in the enclosed envelope.

VITA:

1. DATE OF BIRTH Month | Day | Year	2. STATE OR COUNTRY OF BIRTH	3. STATE OR COUNTRY OF SECONDARY SCHOOL GRADUATION	4. SEX ☐ 1 - MALE ☐ 2 - FEMALE

5. CITIZENSHIP (check one)
☐ 6 - USA
☐ 7 - USA APPLIED FOR
☐ 8 - NON-USA, permanent resident (specify country) ______
☐ 9 - NON-USA (specify country) ______

6. I regard myself professionally as a (an): (check only one)
☐ X0 - Astronomer
☐ 20 - Biologist
☐ 25 - Medical Scientist
☐ 40 - Chemist
☐ 50 - Economist
☐ X3 - Engineer
☐ 10 - Geologist
☐ 60 - Linguist
☐ 70 - Mathematician
☐ 85 - Meteorologist
☐ 80 - Physicist
☐ 90 - Psychologist
☐ 95 - Sociologist
☐ 75 - Statistician
☐ XX - Other (specify) ______

EDUCATION:

7. COLLEGE, UNIVERSITY, OR OTHER INSTITUTION (Include city and state)	EARNED DEGREE, IF ANY	YEAR OF DEGREE	MAJOR	MINOR

CURRENT PROFESSIONAL EMPLOYMENT:

8. Please check the box which most fully describes your current employment status. Check only one.
☐ 1 - Full-time professionally employed
☐ 2 - Part-time professionally employed
☐ 3 - Full-time professionally employed, part-time student
☐ 4 - Student, part-time employed (Graduate Assistants use this code)
☐ 5 - Student, not employed
☐ 6 - Not employed, and seeking employment
☐ 7 - Not employed, and not seeking employment
☐ 8 - Employed, but not in professional work
☐ 9 - Retired

9. Please give name of present principal employer and actual place of employment. (If not employed currently, omit Items 9 through 12. Begin again with Item 13.)

______ Name of present principal employer
______ Actual place of employment (city and state)

10. Check the box of the category which is most appropriate for your present principal employer. Check only one.
☐ 1 - PRIVATE INDUSTRY OR BUSINESS
☐ A - SELF-EMPLOYED
☐ 2 - COLLEGE OR UNIVERSITY, OTHER THAN MEDICAL SCHOOL (specify department or other organizational unit) ______
☐ M - MEDICAL SCHOOL
☐ S - SECONDARY SCHOOL OR SCHOOL SYSTEM
☐ F - FEDERAL GOVERNMENT—CIVILIAN EMPLOYEE
☐ C - USPHS—COMMISSIONED CORPS
☐ L - MILITARY SERVICE—ACTIVE DUTY
☐ U - OTHER GOVERNMENT AGENCY (specify) ______
☐ H - NONPROFIT HOSPITAL OR CLINIC
☐ N - NONPROFIT ORGANIZATION, OTHER THAN HOSPITAL, CLINIC, OR EDUCATIONAL INSTITUTION
☐ 9 - OTHER (specify) ______

11. Please give the principal service you perform or product on which you work. ______

12. From the accompanying specialties list, select the scientific specialization most closely related to your PRESENT employment and enter both the number and specialty title on the lines below.

______ Number
______ Specialty Title

—PLEASE COMPLETE OTHER SIDE—

CURRENT PROFESSIONAL EMPLOYMENT CONTINUED

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13. Number your first and second most important kind of activity, in terms of working time devoted, by entering "1" and "2" on the appropriate lines below.

___ 1 - MANAGEMENT OR ADMINISTRATION OF RESEARCH AND DEVELOPMENT
___ 4 - MANAGEMENT OR ADMINISTRATION OF OTHER THAN RESEARCH AND DEVELOPMENT
___ 5 - TEACHING (State Academic Rank) ___
___ 2 - BASIC RESEARCH
___ 3 - APPLIED RESEARCH
___ 6 - DEVELOPMENT OR DESIGN
___ 8 - CONSULTING
___ 9 - OTHER (specify) ___

14. Is ANY of your work being supported or sponsored by U. S. Government funds? ☐ Yes ☐ No ☐ Don't know
If yes, is your work related to any of the following programs:

☐ 1 - Agriculture
☐ 2 - Atomic energy
☐ 3 - Defense
☐ 4 - Education
☐ 5 - Health
☐ 6 - International
☐ 7 - Natural resources
☐ 8 - Public works
☐ 9 - Space
☐ 0 - Other program (specify) ___

NOTE: Salary and income information is regarded as confidential and will be used for statistical purposes only. It will NOT be released in any way that will allow it to be identified with you.

15. BASIC ANNUAL SALARY (JAN. 1966): Please give the basic annual salary associated with your principal professional employment as of Jan. 1966. $ ___

If academically employed, check whether salary is for ☐ 9-10 mos. or ☐ 11-12 mos.

(Basic Annual Salary is your annual salary before deductions for income tax, social security, retirement, etc., but does not include bonuses, overtime, summer teaching, or other payment for professional work.) Do not include rental or subsistence allowances.

16. ESTIMATED GROSS ANNUAL PROFESSIONAL INCOME (Jan. 1 to Dec. 31, 1966): Please give your estimated gross professional income from all professional activities for the year which will end December 31, 1966. $ ___

(Gross Annual Professional Income is ALL payments received for professional activities including basic salary before deductions, plus bonuses, royalties, fees, honoraria, rental and subsistence allowances, etc.)

17. How many years of professional work experience, including teaching, have you had? ☐

[illegible]

18. From the accompanying specialties list, select and enter on the lines below in decreasing order the four specialties in which you consider you have your greatest scientific competence, based on your total educational and work experience.

Greatest: ___ Number ___ Specialty Title
Second: ___ Number ___ Specialty Title
Third: ___ Number ___ Specialty Title
Fourth: ___ Number ___ Specialty Title

18a. Is your professional competence primarily characterized as ☐ Theoretical ☐ Experimental ☐ Both

LANGUAGE AND AREA KNOWLEDGES:

19. FOREIGN LANGUAGE: List the languages (other than English) in which you have knowledge and indicate with a check mark (✓) your proficiency.

If you have no foreign language competence, check here. ☐

NAME OF LANGUAGE(S)	PROFICIENCY								
	CAN PREPARE AND DELIVER LECTURES		CAN CONVERSE		HAVE FACILITY TO TRANSLATE TECHNICAL JOURNALS		CAN READ TECHNICAL ARTICLES FOR OWN USE		SOME KNOWLEDGE, BUT CAN'T USE AS A MEDIUM OF COMMUNICATION 9
	FLUENTLY 1	SUPERFICIALLY 2	FLUENTLY 3	PASSABLY 4	INTO ENGLISH 5	FROM ENGLISH 6	EASILY 7	WITH DIFFICULTY 8	

20. AREA KNOWLEDGE: List the foreign countries or U. S. geographic areas in which you have a professional specialization gained by residence, research, or travel.

COUNTRY OR AREA	TOTAL YEARS RESIDENCE OR SPECIALIZATION	YEAR LAST VISITED OR SPECIALIZED	NATURE OF YOUR KNOWLEDGE OR SPECIALIZATION

21. SOCIETY MEMBERSHIP: Circle the number in front of all societies of which you are a member. For write-ins include only national professional societies and use identifying words in full:

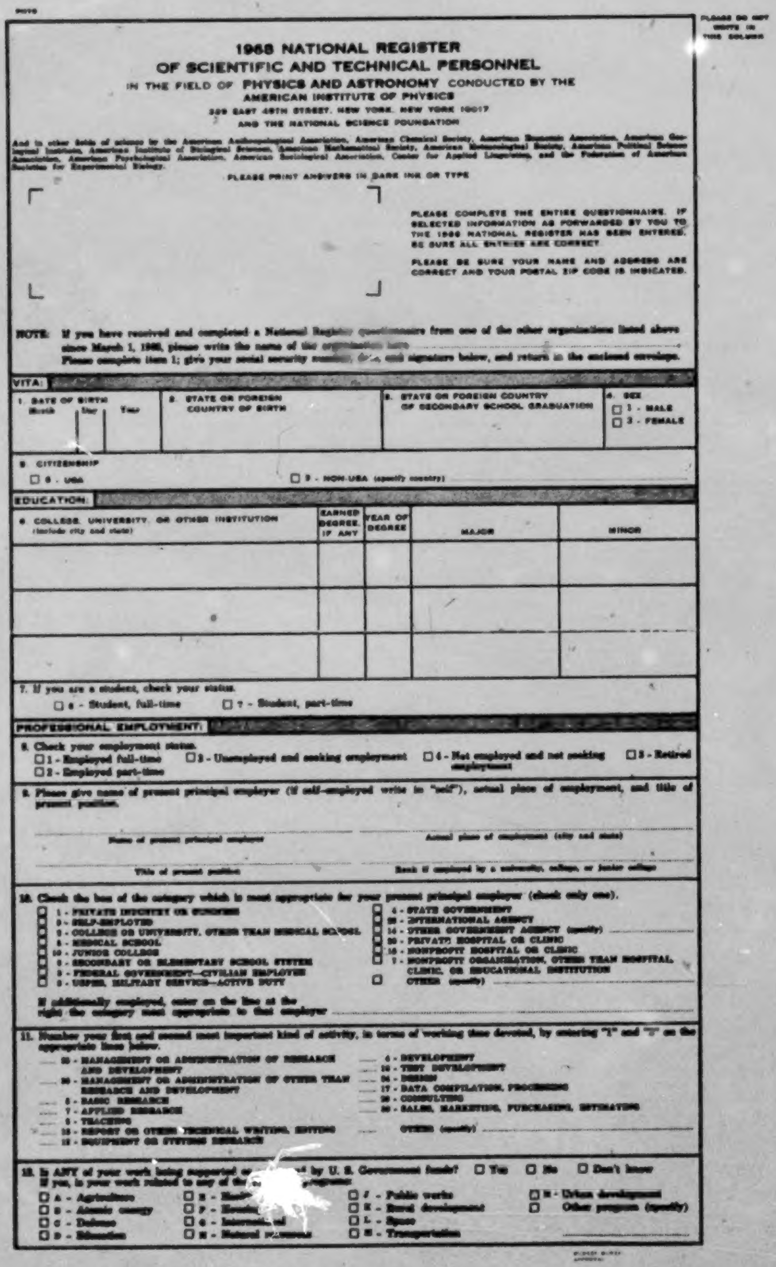
[illegible]. AMERICAN PHYSICAL SOCIETY
[illegible]. OPTICAL SOCIETY OF AMERICA
[illegible]. ACOUSTICAL SOCIETY OF AMERICA
[illegible]. SOCIETY OF RHEOLOGY
[illegible]. AMERICAN ASSOCIATION OF PHYSICS TEACHERS
[illegible]. AMERICAN ASTRONOMICAL SOCIETY
[illegible]. AMERICAN CRYSTALLOGRAPHIC ASSOCIATION
[illegible]. OTHERS (specify) ___
[illegible]. NONE

22. Please give a mailing or forwarding address through which you can always be reached if different from address on reverse side.

___
C/O Number Street City State Zip Code

DATE PREPARED
SOCIAL SECURITY NO.
SIGNATURE: (Please Sign Full Name)

23. If you wish to add to the above information concerning your professional employment(s) or qualifications, please comment below or on an attached sheet, referring to item numbers where appropriate.



PHOTO

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1968 NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

IN THE FIELD OF **PHYSICS AND ASTRONOMY** CONDUCTED BY THE
AMERICAN INSTITUTE OF PHYSICS
335 EAST 45TH STREET, NEW YORK, NEW YORK 10017
AND THE NATIONAL SCIENCE FOUNDATION

And in other fields of science by the American Anthropological Association, American Chemical Society, American Economic Association, American Geological Institute, American Institute of Biological Sciences, American Mathematical Society, American Meteorological Society, American Political Science Association, American Psychological Association, American Sociological Association, Center for Applied Linguistics, and the Federation of American Societies for Experimental Biology.

PLEASE PRINT ANSWERS IN DARK INK OR TYPE

PLEASE COMPLETE THE ENTIRE QUESTIONNAIRE. IF SELECTED INFORMATION AS FORWARDED BY YOU TO THE 1966 NATIONAL REGISTER HAS BEEN ENTERED, BE SURE ALL ENTRIES ARE CORRECT.

PLEASE BE SURE YOUR NAME AND ADDRESS ARE CORRECT AND YOUR POSTAL ZIP CODE IS INDICATED.

NOTE: If you have received and completed a National Register questionnaire from one of the other organizations listed above since March 1, 1968, please write the name of the organization here ....
Please complete item 1; give your social security number, date, and signature below, and return in the enclosed envelope.

VITA:

1. DATE OF BIRTH Month / Day / Year	2. STATE OR FOREIGN COUNTRY OF BIRTH	3. STATE OR FOREIGN COUNTRY OF SECONDARY SCHOOL GRADUATION	4. SEX ☐ 1 - MALE ☐ 2 - FEMALE

5. CITIZENSHIP
☐ 6 - USA ☐ 9 - NON-USA (specify country) ....

EDUCATION:

6. COLLEGE, UNIVERSITY, OR OTHER INSTITUTION (include city and state)	EARNED DEGREE, IF ANY	YEAR OF DEGREE	MAJOR	MINOR

7. If you are a student, check your status.
☐ 6 - Student, full-time ☐ 7 - Student, part-time

PROFESSIONAL EMPLOYMENT:

8. Check your employment status.
☐ 1 - Employed full-time
☐ 2 - Employed part-time
☐ 3 - Unemployed and seeking employment
☐ 4 - Not employed and not seeking employment
☐ 5 - Retired

9. Please give name of present principal employer (if self-employed write in "self"), actual place of employment, and title of present position.

.... Name of present principal employer
.... Actual place of employment (city and state)
.... Title of present position
.... Rank if employed by a university, college, or junior college

10. Check the box of the category which is most appropriate for your present principal employer (check only one).
☐ 1 - PRIVATE INDUSTRY OR BUSINESS
☐ 2 - SELF-EMPLOYED
☐ 3 - COLLEGE OR UNIVERSITY, OTHER THAN MEDICAL SCHOOL
☐ 8 - MEDICAL SCHOOL
☐ 10 - JUNIOR COLLEGE
☐ 5 - SECONDARY OR ELEMENTARY SCHOOL SYSTEM
☐ 3 - FEDERAL GOVERNMENT—CIVILIAN EMPLOYEE
☐ 9 - USPHS, MILITARY SERVICE—ACTIVE DUTY
☐ 4 - STATE GOVERNMENT
☐ 20 - INTERNATIONAL AGENCY
☐ 14 - OTHER GOVERNMENT AGENCY (specify) ....
☐ 20 - PRIVATE HOSPITAL OR CLINIC
☐ 15 - NONPROFIT HOSPITAL OR CLINIC
☐ 7 - NONPROFIT ORGANIZATION, OTHER THAN HOSPITAL, CLINIC, OR EDUCATIONAL INSTITUTION
☐ OTHER (specify) ....

If additionally employed, enter on the line at the right the category most appropriate to that employer ....

11. Number your first and second most important kind of activity, in terms of working time devoted, by entering "1" and "2" on the appropriate lines below.
___ 33 - MANAGEMENT OR ADMINISTRATION OF RESEARCH AND DEVELOPMENT
___ 30 - MANAGEMENT OR ADMINISTRATION OF OTHER THAN RESEARCH AND DEVELOPMENT
___ 5 - BASIC RESEARCH
___ 7 - APPLIED RESEARCH
___ 8 - TEACHING
___ 15 - REPORT OR OTHER TECHNICAL WRITING, EDITING
___ 12 - EQUIPMENT OR SYSTEMS RESEARCH
___ 4 - DEVELOPMENT
___ 16 - TEST DEVELOPMENT
___ 14 - DESIGN
___ 17 - DATA COMPILATION, PROCESSING
___ 19 - CONSULTING
___ 30 - SALES, MARKETING, PURCHASING, ESTIMATING
___ OTHER (specify) ....

12. Is ANY of your work being supported or [illegible] by U. S. Government funds? ☐ Yes ☐ No ☐ Don't know
If yes, is your work related to any of the [illegible] programs:
☐ A - Agriculture
☐ B - Atomic energy
☐ C - Defense
☐ D - Education
☐ E - Heal[illegible]
☐ F - Housin[illegible]
☐ G - International
☐ H - Natural resources
☐ J - Public works
☐ K - Rural development
☐ L - Space
☐ M - Transportation
☐ N - Urban development
☐ Other program (specify) ....

PLEASE DO NOT WRITE IN THIS COLUMN

PROFESSIONAL EMPLOYMENT CONTINUED

13. From the specialties list (see overleaf), select and enter both the number and scientific specialty most closely related to your **PRESENT** principal employment; or write in your specialty if it is not on the list.

Number ____________ Specialty Title ____________

Also enter other scientific specialties in which you have competence.

one: ____________ Number ____________ Specialty Title ____________ three: ____________ Number ____________ Specialty Title

two: ____________ Number ____________ Specialty Title ____________ four: ____________ Number ____________ Specialty Title

NOTE: Salary and income information is regarded as confidential and will be used for statistical purposes only. It will NOT be released in any way that will allow it to be identified with you.

14. 19[illegible] BASIC ANNUAL SALARY: Please give the basic annual salary associated with your principal professional work to the nearest hundred dollars.

$ ____________

If academically employed, check whether salary is for ☐ 9-10 mos. or ☐ 11-12 mos.

(Basic Annual Salary is your annual salary before deductions for income tax, social security, retirement, etc., but does not include bonuses, overtime, summer teaching, or other payment for professional work. Do not include rental or subsistence allowances.)

15. ESTIMATED GROSS ANNUAL PROFESSIONAL INCOME (Jan. 1 to Dec. 31, 19[illegible]): Please give your estimated gross income from all professional activities for the year.

$ ____________

(Gross Annual Professional Income is ALL payment received for professional activities including basic salary before deductions, plus bonuses, royalties, fees, honoraria, etc.)

16. How many years of professional work experience, including teaching, have you had? ☐

LANGUAGE AND AREA KNOWLEDGE:

17. FOREIGN LANGUAGE: List the languages (other than English) in which you have competence and indicate your proficiencies. If you have no foreign competence, check here ☐

NAME OF LANGUAGE(S)	PROFICIENCY								
	CAN PREPARE AND DELIVER LECTURES		CAN CONVERSE		HAVE FACILITY TO TRANSLATE TECHNICAL JOURNALS		CAN READ TECHNICAL ARTICLES FOR OWN USE		SOME KNOWLEDGE BUT CAN'T USE AS A MEDIUM OF COMMUNICATION 9
	EASILY 1	WITH DIFFICULTY 2	FLUENTLY 3	PASSABLY 4	INTO ENGLISH 5	FROM ENGLISH 6	EASILY 7	WITH DIFFICULTY 8	

18. AREA KNOWLEDGE: List the foreign countries of which you have a knowledge gained by residence or research.

COUNTRY	TOTAL YEARS RESIDENCE	YEAR LAST VISITED	NATURE OF YOUR KNOWLEDGE

PROFESSIONAL IDENTIFICATION:

19. I regard myself professionally as a (an): ____________

20. SOCIETY MEMBERSHIP: Check the appropriate boxes for all Societies of which you are a member. For write-ins include only national professional societies and use identifying words in full:

☐ A - AMERICAN PHYSICAL SOCIETY
☐ B - OPTICAL SOCIETY OF AMERICA
☐ C - ACOUSTICAL SOCIETY OF AMERICA
☐ D - SOCIETY OF RHEOLOGY
☐ E - AMERICAN ASSOCIATION OF PHYSICS TEACHERS
☐ F - AMERICAN ASTRONOMICAL SOCIETY
☐ G - AMERICAN CRYSTALLOGRAPHIC ASSOCIATION
☐ H - AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE
☐ J - AMERICAN INSTITUTE OF AERONAUTICS & ASTRONAUTICS
☐ K - AMERICAN SOCIETY FOR METALS
☐ L - AMERICAN VACUUM SOCIETY
☐ M - INSTRUMENT SOCIETY OF AMERICA
☐ N - SOCIETY FOR APPLIED SPECTROSCOPY
☐ P - SIGMA PI SIGMA
☐ T - OTHERS (specify) ____________
☐ Z - NONE

21. Please give a mailing or forwarding address through which you can always be reached if different from address above.

____
C/O Number Street City State Zip Code

DATE PREPARED:		SIGNATURE: (Please Sign Full Name)
SOCIAL SECURITY ACCOUNT NO.		

SPECIALTIES LIST

FOR USE WITH

1968 NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

In the section PROFESSIONAL EMPLOYMENT on the 1968 National Register Questionnaire you are requested to select from this list the specialty most closely related to your present employment and other specialties in which you may have competence (item 13). Please use the specialty title from this selected list; if you select the "Other" category, use that code number and write in your brief specialty title.

Acoustics
03210—Applied acoustics, instruments and apparatus
03228—Architectural acoustics
03236—Ear and hearing
03244—Electroacoustics
03251—Infrasonics
03269—Mechanical vibrations and shock
03277—Musical instruments and music
03285—Noise
03319—Speech communications
03327—Theory of waves and vibrations
03335—Ultrasonics
03343—Underwater sound
03392—Other (specify)

Atomic and molecular physics
03418—Atomic, ionic, and molecular beams
03426—Atomic masses and abundances
03434—Atomic structure and spectra
03442—Chemical bonds and structure
03459—Electron paramagnetic resonance
03467—Impact and scattering phenomena
03475—Mass spectroscopy
03483—Molecular structure and spectra
03517—Nuclear magnetic resonance
03590—Other (specify)

Electromagnetism
03616—Antenna theory
03624—Electrical measurements and instruments
03632—Electromagnetic waves
03640—Electromagnetic wave propagation
03657—Electron dynamics
03665—Electron microscopy, ion optics
03673—Gas discharge
03681—Magnetism
03715—Masers and such devices
03723—Microwaves
03731—Physical electronics
03749—Quantum electronics
03756—X-ray interactions
03764—X-ray phenomena
03772—X-ray technology
03798—Other (specify)

Electronics
03814—Electron ballistics
03822—Electron tubes
03830—Electronic device circuitry
03848—Electronics instrumentation
03855—Electron emission
03863—Gas devices
03871—Quantum electronics
03889—Semiconductor devices
03913—Solid state electronics
03996—Other (specify)

Elementary particles
04010—Cosmic rays
04028—High energy accelerators
04036—High energy phenomena
04044—Particle detection
04051—[illegible] computer analysis
04093—Other (specify)

Mechanics
04119—Analytical mechanics
04127—Ballistics and flight dynamics
04135—Elasticity
04143—Friction
04150—High pressure physics
04168—Impact phenomena
04176—Instruments and measurements
04192—Other (specify)

Optics
04416—Atmospheric and space optics
04424—Color, colorimetry
04432—Fiber optics
04440—Geometrical optics
04449—Holography
04457—Information theory, communication, image evaluation
04465—Infrared phenomena
04473—Interferometry
04481—Lasers
04515—Lenses
04523—Optical instruments, techniques, and devices
04531—Optical materials
04549—Photography, illumination
04556—Physical optics
04564—Physiological optics
04572—Properties of thin films
04580—Radiometry, photometry
04614—Spectroscopy
04697—Other (specify)

Nuclear physics
04218—Accelerators, detectors
04226—Neutrons
04234—Nuclear properties
04242—Nuclear reactions and scattering
04259—Nuclear spectroscopy
04267—Radiation effects
04275—Radioactive materials, isotopes
04283—Reactors
04317—Shielding
04390—Other (specify)

Physics of fluids
04713—Aerodynamics
04721—Aerosols
04739—Boundary layer effects
04747—Cavities and jets
04754—Compressible fluid dynamics
04762—Explosion phenomena
04770—High temperature flow
04788—Incompressible fluid dynamics
04812—Magneto fluid dynamics
04820—Plasma physics
04838—Rarefied gas flow
04846—Rheology (including plastic flow)
04853—Shock wave phenomena
04861—Structure and properties of fluids
04879—Superfluidity
04887—Transport phenomena, diffusion
04911—Turbulence
04929—Viscosity
04994—Other (specify)

Solid state physics
05017—Ceramics
05025—Cooperative phenomena
05033—Crystallography
05041—Dielectrics (including fluids)
05058—Dislocations and plasticity
05066—Dynamics of crystal lattices
05074—Electrical properties of surfaces and junctions
05082—Electron emission
05116—Ferromagnetism
05124—High polymers and glasses
05132—Internal friction
05140—Lattice effects and diffusion
05157—Luminescence
05165—Optical properties
05173—Paramagnetism and diamagnetism
05181—Photoconductivity and related phenomena
05215—Photoelectric phenomena
05223—Piezoelectricity and ferroelectricity
05231—Quantum mechanics of solids
05249—Radiation damage
05256—Resonance phenomena
05264—Semiconductors
05272—Superconductivity
05280—Surface structure and kinetics
05314—Thermal conduction in solid state
05322—Thin films
05397—Other (specify)

Thermal physics
05413—Calorimetry
05421—Heat transmission
05439—High temperature physics
05447—Low temperature physics
05454—Temperature and its measurement
05462—Thermal properties
05470—Thermodynamics
05488—Thermodynamic relations, equations of state
05512—Thermodynamic tables
05595—Other (specify)

Other physics specialties
05611—Constants, standards, units, metrology, conversion factors
05629—Energy conversion problems
05637—Field theory
05645—High vacuum techniques
05652—Kinetic theory
05660—Many body theory
05678—Mathematical physics
05686—Mossbauer effect
05710—Physical metallurgy
05728—Physical properties of materials
05736—Quantum mechanics
05744—Radiation and health physics
05751—Relativity and gravitation
05769—Statistical mechanics
05777—History of physics and/or astronomy
05785—Teaching of physics and/or astronomy
05793—Other (specify)

Astronomy

00018—Astrometry
00026—Astrophysics
00034—Celestial mechanics
00042—Comets, meteors, interplanetary medium
00059—Cosmology and cosmogony
00067—Design of astronomical instruments
00075—Galaxies
00083—Navigation, geodetic astronomy
00117—Origin of cosmic rays
00125—Photometry of astronomical sources
00133—Physics of the interstellar medium
00141—Planets, satellites
00158—Radio astronomy
00166—Space astronomy
00174—Spectroscopy of astronomical sources
00182—Star systems and statistical astronomy
00216—Stellar energy generation, nucleogenesis, stellar evolution
00224—The sun
00232—Variable stars
00299—Other (specify)

Atmospheric structure and dynamics

19919—Aeronomy
19927—Air-sea interaction
19935—Atmospheric chemistry and radioactivity
19943—Atmospheric dynamics and thermodynamics
19950—Atmospheric electricity
19968—Atmospheric optics and acoustics
19976—Aurora, airglow
19984—Cloud and precipitation physics
20016—Cosmic rays
20024—Ionosphere
20032—Macrometeorology
20040—Micrometeorology
20057—Numerical modeling
20065—Planetary atmospheres
20073—Radiative transfer
20081—Turbulence and diffusion
20099—Other (specify)

Biophysics

10314—Bioacoustics
10322—Bioelectricity
10330—Bio-optics
10348—Biosystems, control communications
10355—Biothermics and bioenergetics
10363—Biotransport, membrane physics
10371—Cellular
10389—Crystallography
10413—Methodology
10421—Molecular
10496—Other (specify)

Physical chemistry

20214—Catalysis and surface chemistry
20222—Chemical and phase equilibria
20230—Chemical kinetics; gas phase and photochemistry
20248—Chemical kinetics; liquid phase
20255—Colloid chemistry
20263—Crystallography
20271—Electrochemistry
20289—Energy transfer and relaxation processes
20313—Flames and explosives
20321—Fused salts
20339—High temperature chemistry
20347—Ion exchange and membrane phenomena
20354—Isotope effects
20362—Liquid state and solutions; electrolytes and non-electrolytes
20370—Molecular spectroscopy
20388—Molecular structure
20412—Nuclear and radiochemistry
20420—Polymers in bulk; morphology, phase transitions, rheology, and mechanical properties
20438—Polymers in solution; thermodynamics, hydrodynamics, and spectroscopy
20446—Quantum and valence theory
20453—Radiation and hot-atom chemistry
20461—Solid state chemistry
20487—Thermochemistry
20495—Other (specify)

Solar/Planetary geophysics

20719—Aeronomy
20727—Aurora, airglow
20735—Cosmic rays
20743—Geomagnetism
20750—Interplanetary particles and fields
20768—Ionosphere
20776—Lunar and planetary geophysics/geology
20784—Magnetospheric particles and waves
20818—Planetary atmospheres
20826—Solar physics
20834—Tektites and meteorites
20891—Other (specify)

Solid-earth geophysics

20917—Exploration seismology
20925—Exploration geophysics: gravity
20933—Exploration geophysics: magnetic
20941—Geomagnetism and electricity
20958—Gravity
20966—Marine geophysics
20974—Physical properties of natural materials
20982—Seismic waves
21014—Tectonics (including heat flow)
21022—Volcanology
21097—Other (specify)

OTHER FIELDS OF SCIENCE

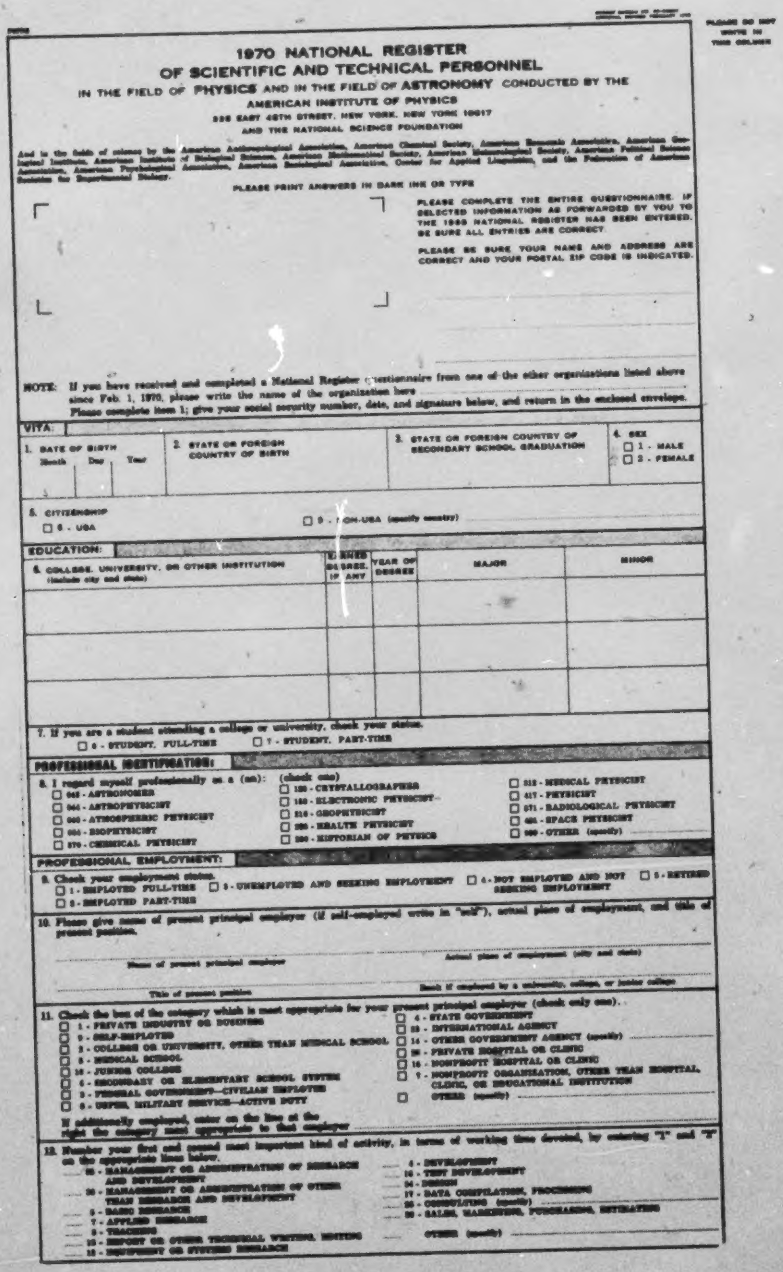
00802—Atmospheric Science
01507—Chemistry
04409—Earth Sciences

08607—Mathematics
24609—Computer Science
09603—Statistics

12309—Agricultural Sciences
12809—Biological and Biomedical Sciences

14704—Psychology
15204—Anthropology
16709—Economics
17004—Linguistics
18003—Political Science
19003—Sociology

21105—Other (specify)



PLEASE DO NOT WRITE IN THIS COLUMN

1970 NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

IN THE FIELD OF **PHYSICS** AND IN THE FIELD OF **ASTRONOMY** CONDUCTED BY THE
AMERICAN INSTITUTE OF PHYSICS
335 EAST 45TH STREET, NEW YORK, NEW YORK 10017
AND THE NATIONAL SCIENCE FOUNDATION

And in the fields of science by the American Anthropological Association, American Chemical Society, American Economic Association, American Geological Institute, American Institute of Biological Sciences, American Mathematical Society, American Meteorological Society, American Political Science Association, American Psychological Association, American Sociological Association, Center for Applied Linguistics, and the Federation of American Societies for Experimental Biology.

PLEASE PRINT ANSWERS IN DARK INK OR TYPE

PLEASE COMPLETE THE ENTIRE QUESTIONNAIRE. IF SELECTED INFORMATION AS FORWARDED BY YOU TO THE 1968 NATIONAL REGISTER HAS BEEN ENTERED, BE SURE ALL ENTRIES ARE CORRECT.

PLEASE BE SURE YOUR NAME AND ADDRESS ARE CORRECT AND YOUR POSTAL ZIP CODE IS INDICATED.

NOTE: If you have received and completed a National Register questionnaire from one of the other organizations listed above since Feb. 1, 1970, please write the name of the organization here ______ Please complete item 1; give your social security number, date, and signature below, and return in the enclosed envelope.

VITA:

1. DATE OF BIRTH Month Day Year	2. STATE OR FOREIGN COUNTRY OF BIRTH	3. STATE OR FOREIGN COUNTRY OF SECONDARY SCHOOL GRADUATION	4. SEX ☐ 1 - MALE ☐ 2 - FEMALE

5. CITIZENSHIP
☐ 8 - USA ☐ 9 - NON-USA (specify country) ______

EDUCATION:

6. COLLEGE, UNIVERSITY, OR OTHER INSTITUTION (include city and state)	EARNED DEGREE, IF ANY	YEAR OF DEGREE	MAJOR	MINOR

7. If you are a student attending a college or university, check your status.
☐ 6 - STUDENT, FULL-TIME ☐ 7 - STUDENT, PART-TIME

PROFESSIONAL IDENTIFICATION:

8. I regard myself professionally as a (an): (check one)
☐ 045 - ASTRONOMER
☐ 044 - ASTROPHYSICIST
☐ [illegible] - ATMOSPHERIC PHYSICIST
☐ [illegible] - BIOPHYSICIST
☐ 570 - CHEMICAL PHYSICIST
☐ 120 - CRYSTALLOGRAPHER
☐ 180 - ELECTRONIC PHYSICIST
☐ 210 - GEOPHYSICIST
☐ [illegible] - HEALTH PHYSICIST
☐ [illegible] - HISTORIAN OF PHYSICS
☐ 312 - MEDICAL PHYSICIST
☐ 417 - PHYSICIST
☐ 571 - RADIOLOGICAL PHYSICIST
☐ [illegible] - SPACE PHYSICIST
☐ 999 - OTHER (specify) ______

PROFESSIONAL EMPLOYMENT:

9. Check your employment status.
☐ 1 - EMPLOYED FULL-TIME
☐ 2 - EMPLOYED PART-TIME
☐ 3 - UNEMPLOYED AND SEEKING EMPLOYMENT
☐ 4 - NOT EMPLOYED AND NOT SEEKING EMPLOYMENT
☐ 5 - RETIRED

10. Please give name of present principal employer (if self-employed write in "self"), actual place of employment, and title of present position.

______ Name of present principal employer
______ Actual place of employment (city and state)
______ Title of present position
______ Dept. if employed by a university, college, or junior college

11. Check the box of the category which is most appropriate for your present principal employer (check only one).
☐ 1 - PRIVATE INDUSTRY OR BUSINESS
☐ 9 - SELF-EMPLOYED
☐ 2 - COLLEGE OR UNIVERSITY, OTHER THAN MEDICAL SCHOOL
☐ 3 - MEDICAL SCHOOL
☐ 18 - JUNIOR COLLEGE
☐ 6 - SECONDARY OR ELEMENTARY SCHOOL SYSTEM
☐ 3 - FEDERAL GOVERNMENT—CIVILIAN EMPLOYEE
☐ 8 - UNIFORMED MILITARY SERVICE—ACTIVE DUTY
☐ 4 - STATE GOVERNMENT
☐ 13 - INTERNATIONAL AGENCY
☐ 14 - OTHER GOVERNMENT AGENCY (specify) ______
☐ [illegible] - PRIVATE HOSPITAL OR CLINIC
☐ 16 - NONPROFIT HOSPITAL OR CLINIC
☐ 7 - NONPROFIT ORGANIZATION, OTHER THAN HOSPITAL, CLINIC, OR EDUCATIONAL INSTITUTION
☐ OTHER (specify) ______

If additionally employed, enter on the line at the right the category most appropriate to that employer ______

12. Number your first and second most important kind of activity, in terms of working time devoted, by entering "1" and "2" on the appropriate lines below.
___ [illegible] - MANAGEMENT OR ADMINISTRATION OF RESEARCH AND DEVELOPMENT
___ [illegible] - MANAGEMENT OR ADMINISTRATION OF OTHER THAN RESEARCH AND DEVELOPMENT
___ 5 - BASIC RESEARCH
___ 7 - APPLIED RESEARCH
___ 8 - TEACHING
___ 15 - REPORT OR OTHER TECHNICAL WRITING, EDITING
___ 18 - EQUIPMENT OR SYSTEMS RESEARCH
___ 4 - DEVELOPMENT
___ 16 - TEST DEVELOPMENT
___ [illegible] - DESIGN
___ 17 - DATA COMPILATION, PROCESSING
___ [illegible] - CONSULTING (specify) ______
___ [illegible] - SALES, MARKETING, PURCHASING, ESTIMATING
___ OTHER (specify) ______

PROFESSIONAL EMPLOYMENT CONTINUED

13. From the specialties list (see overleaf), select and enter both the number and title of the scientific specialty most closely related to your PRESENT principal employment; or write in your specialty if it is not on the list.

Number ______ Specialty Title ______

14. Is ANY of your work being supported or sponsored by U. S. Government funds? ☐ Yes ☐ No ☐ Don't know

If yes, is your work related to any of the following programs:

- ☐ A - AGRICULTURE
- ☐ B - ATOMIC ENERGY
- ☐ C - DEFENSE
- ☐ D - EDUCATION
- ☐ E - HEALTH
- ☐ F - HOUSING
- ☐ G - INTERNATIONAL
- ☐ H - NATURAL RESOURCES
- ☐ J - PUBLIC WORKS
- ☐ K - RURAL DEVELOPMENT
- ☐ L - SPACE
- ☐ M - TRANSPORTATION
- ☐ N - URBAN DEVELOPMENT
- ☐ OTHER PROGRAM (specify) ______

NOTE: Salary and income information is regarded as confidential and will be used for statistical purposes only. It will NOT be released in any way that will allow it to be identified with you.

15. 1970 BASIC ANNUAL SALARY: Please give the basic annual salary associated with your principal professional work to the nearest hundred dollars.

$ ______

If academically employed, check whether salary is for: ☐ 9-10 mos. or ☐ 11-12 mos.

(Basic Annual Salary is your annual salary before deductions for income tax, social security, retirement, etc., but does not include bonuses, overtime, summer teaching, or other payment for professional work. Do not include rental or subsistence allowances.)

16. ESTIMATED GROSS ANNUAL PROFESSIONAL INCOME (Jan. 1 to Dec. 31, 1970): Please give your estimated gross income from all professional activities for the year.

$ ______

(Gross Annual Professional Income is ALL payment received for professional activities including basic salary before deductions, plus bonuses, royalties, fees, honoraria, etc.)

17. How many years of professional work experience, including teaching, have you had? ☐

SCIENTIFIC COMPETENCE:

18. From the specialties list (see overleaf), select and enter on the lines below in decreasing order the four specialties in which you currently have your greatest scientific competence, based on your total educational and work experience. Enter only scientific specializations.

Greatest: ______ Number ______ Specialty Title

Second: ______ Number ______ Specialty Title

Third: ______ Number ______ Specialty Title

Fourth: ______ Number ______ Specialty Title

18a. Is your professional competence primarily characterized as ☐ Theoretical ☐ Experimental ☐ Both

LANGUAGE AND AREA KNOWLEDGE:

19. FOREIGN LANGUAGE: List the languages (other than English) in which you have competence and indicate your proficiencies. If you have no foreign language competence, check here. ☐

NAME OF LANGUAGE(S)	PROFICIENCY								
	CAN PREPARE AND DELIVER LECTURES		CAN CONVERSE		HAVE FACILITY TO TRANSLATE TECHNICAL JOURNALS		CAN READ TECHNICAL ARTICLES FOR OWN USE		SOME KNOWLEDGE BUT CAN'T USE AS A MEDIUM OF COMMUNICATION 9
	EASILY 1	WITH DIFFICULTY 2	FLUENTLY 3	PASSABLY 4	INTO ENGLISH 5	FROM ENGLISH 6	EASILY 7	WITH DIFFICULTY 8	

20. AREA KNOWLEDGE: List the foreign countries of which you have a knowledge gained by residence or research.

COUNTRY	TOTAL YEARS RESIDENCE	YEAR LAST VISITED	NATURE OF YOUR KNOWLEDGE

PROFESSIONAL AFFILIATION:

21. SOCIETY AFFILIATION: Check the appropriate boxes for all Societies of which you are a member. For write-ins include only national professional societies and use identifying words in full:

- ☐ 1 - AMERICAN PHYSICAL SOCIETY
- ☐ 2 - OPTICAL SOCIETY OF AMERICA
- ☐ 3 - ACOUSTICAL SOCIETY OF AMERICA
- ☐ 4 - SOCIETY OF RHEOLOGY
- ☐ 5 - AMERICAN ASSOCIATION OF PHYSICS TEACHERS
- ☐ 6 - AMERICAN ASTRONOMICAL SOCIETY
- ☐ 7 - AMERICAN CRYSTALLOGRAPHIC ASSOCIATION
- ☐ 8 - AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE
- ☐ 9 - AMERICAN INSTITUTE OF AERONAUTICS & ASTRONAUTICS
- ☐ 10 - AMERICAN SOCIETY FOR METALS
- ☐ 11 - AMERICAN VACUUM SOCIETY
- ☐ 12 - INSTRUMENT SOCIETY OF AMERICA
- ☐ 13 - SOCIETY FOR APPLIED SPECTROSCOPY
- ☐ 14 - S P S
- ☐ 15 - AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
- ☐ 20 - OTHERS (specify) ______
- ☐ 29 - NONE

22. Please give a mailing or forwarding address through which you can always be reached if different from address above.

C/O ______ Number ______ Street ______ City ______ State ______ Zip Code

DATE PREPARED:	SIGNATURE: (Please Sign Full Name)
SOCIAL SECURITY ACCOUNT NO.	

SPECIALTIES LIST

FOR USE WITH

1970 NATIONAL REGISTER OF SCIENTIFIC AND TECHNICAL PERSONNEL

In the sections PROFESSIONAL EMPLOYMENT and SCIENTIFIC COMPETENCE on the 1970 National Register Questionnaire you are requested to select from this list the specialty most closely related to your present employment (item 13) and those in which you consider you have your greatest professional competence (item 18). Please use the specialty title from this list; if you select the "Other" category, use that code number and write in your own brief specialty title.

Acoustics

5771—Architectural acoustics
5772—Hearing
5773—Music
5774—Noise
5775—Shock waves
5776—Speech
5777—Ultrasonics
5778—Underwater sound
5781—Vibrations
5789—Other (specify)

Atoms and Molecules

5791—Atomic and molecular ions
5792—Atomic, molecular, and electron beams
5793—Atoms with Z > 2
5794—Collision processes
5795—Free radicals
5796—Hydrogen and helium atoms
5797—Inorganic molecules
5798—Macromolecules and polymers
5801—Mesic and muonic atoms and molecules
5802—Organic molecules
5809—Other (specify)

Biophysics

5961—Bioacoustics
5962—Bioelectricity
5963—Bioenergetics
5964—Biological molecules
5965—Bio-optics
5966—Health and medical physics
5969—Other (specify)

Electromagnetism

5811—Electrical quantities and their measurement
5812—Generation of electromagnetic waves
5813—Infrared, visible, and ultraviolet radiation
5814—Interaction of electromagnetic waves with matter
5815—Magnetism
5816—Propagation of electromagnetic waves
5817—Radiowaves and microwaves
5818—X-rays and gamma rays
5819—Other (specify)

Elementary Particles and Fields

5821—Cosmic rays
5822—Electromagnetic fields, photons
5823—Gravitational fields, gravitons
5824—Hadrons
5825—Leptons
5826—Quantum field theory
5829—Other (specify)

Fluids

5831—Dispersions and colloids
5832—Electric discharges
5833—Fluid mechanics
5834—Gases
5835—Ionization
5836—Liquids
5837—Magnetofluid dynamics
5838—Plasmas
5841—Quantum fluids
5849—Other (specify)

Instrumentation

5971—Antennas, radiators
5972—Astronomical
5973—Beam handling
5974—Circuits and circuit elements
5975—Communication
5976—Electronic
5977—Energy conversion
5978—High pressure
5981—High temperature
5982—Information storage
5983—Lasers and masers
5984—Measuring, testing, and calibrating
5985—Microscopes
5986—NMR-EPR
5987—Nuclear reactors
5988—Particle accelerators
5991—Particle and beam sources
5992—Particle detectors
5993—Photographic
5994—Plasma containment
5995—Radio and microwave
5996—Radio astronomy
5997—Semiconductors
5998—Spectroscopes
6001—Telescopes
6002—Thermometric
6003—Vacuum
6004—X-ray
6009—Other (specify)

Mechanics

5851—Analytical mechanics
5852—Celestial mechanics
5853—Continuum mechanics
5854—Elasticity
5855—Friction
5856—Many body theory
5857—Measurement of mechanical properties
5858—Plasticity
5861—Quantum mechanics
5862—Statistical mechanics
5869—Other (specify)

Nuclei

5871—Nuclear decay and radioactivity
5872—Nuclear reactions and scattering
5873—Nuclear structure and energy levels
5879—Other (specify)

Optics

5881—Colorimetry
5882—Geometric optics
5883—Holography
5884—Lasers
5885—Non-linear optics
5886—Photography
5887—Photometry, radiometry, and illumination
5888—Physical optics
5891—Spectroscopy
5892—Vision
5899—Other (specify)

Physical Chemistry

5671—Catalysis
5672—Chemical and phase equilibria
5673—Chemical kinetics, gas phase and photochemistry
5674—Chemical kinetics, liquid phase
5675—Colloid chemistry
5676—Crystallography
5677—Electrochemistry
5678—Electronic spectroscopy, including far U.V.
5681—Energy transfer and relaxation processes
5682—Equilibrium and thermodynamic relationships
5683—Fast reactions
5684—Flames and explosives
5685—Fused salts
5686—High temperature chemistry
5687—Interfacial chemistry
5688—Ion exchange and membrane phenomena
5692—Liquid state and solutions; electrolytes and non-electrolytes
5693—Molecular spectroscopy
5694—Molecular structure
5695—Nuclear and radiochemistry
5696—Quantum and valence theory
5697—Radiation and hot-atom chemistry
5698—Scattering phenomena
5701—Solid state chemistry
5703—Thermochemistry
5709—Other (specify)

Solid-Earth Geophysics

5161—Exploration, gravity
5162—Exploration, magnetic
5163—Exploration seismology
5164—Geomagnetism and paleomagnetism
5165—Gravity
5166—Heat flow
5167—Physical properties of natural materials
5168—Seismology
5171—Tectonics
5172—Volcanology
5179—Other (specify)

Solids

5901—Acoustic properties
5902—Alloys
5903—Crystal growth
5904—Crystal structure
5905—Dendrites and composites
5906—Dielectrics
5907—Diffusion in solids
5908—Electron states
5911—Electron transport and carrier properties
5912—Imperfections
5913—Interaction of radiation with solids
5914—Lattice mechanics
5915—Luminescence
5916—Magnetic properties
5917—Magnetic resonance
5918—Mechanical properties
5921—Metallic conductors
5922—Mossbauer effect
5923—Non-crystalline states
5924—Optical properties
5925—Semiconductors
5926—Solid state devices
5927—Superconductors
5928—Surfaces, interfaces, films
5931—Thermal properties of solids
5939—Other (specify)

Thermal Physics

5941—High temperature physics
5942—Kinetic theory
5943—Low temperature physics
5944—Phase transitions, changes of state
5945—Statistical mechanics
5946—Thermal measurement techniques
5947—Thermal properties
5948—Thermodynamics
5951—Transport phenomena
5959—Other (specify)

Atmospheric Structure and Dynamics

4991—Aeronomy
4992—Air-sea interaction
4993—Atmospheric chemistry and radioactivity
4994—Atmospheric dynamics, thermodynamics
4995—Atmospheric electricity
4996—Atmospheric optics and acoustics
4997—Aurora, airglow
4998—Cloud and precipitation physics
5001—Cosmic rays
5002—Ionosphere
5003—Mesometeorology
5004—Micrometeorology
5005—Numerical modeling
5006—Planetary atmospheres
5007—Radiative transfer
5008—Turbulence and diffusion
5009—Other (specify)

Solar-Planetary Relationships

5331—Aeronomy
5332—Aurora and airglow
5333—Cosmic rays
5334—Geomagnetic pulsations
5335—Interplanetary particles and fields
5336—Ionosphere
5337—Magnetospheric particles and waves
5338—Solar and planetary physics
5341—Solar wind
5349—Other (specify)

Planetology

5301—Interplanetary matter
5302—Lunar and planetary geology
5303—Lunar and planetary geophysics
5304—Meteorites and tektites
5305—Planetary atmospheres
5306—Planetary magnetic fields
5309—Other (specify)

Additional Astrophysical Specialties

6011—Binary stars
6012—Clusters
6013—Comets, meteors, interplanetary medium
6014—Cosmology
6015—Galaxies
6016—Interstellar medium
6017—Planets and satellites
6018—Quasars, pulsars, X-ray sources
6021—Stellar composition
6022—Stellar evolution
6023—The Sun
6029—Other (specify)

Other Specialties

6031—History of physics or astronomy
6032—Mathematical physics
6033—Philosophy of physics or astronomy
6034—Physics information, dissemination and retrieval
6035—Relativity, gravitation
6036—Teaching of physics or astronomy
6037—Units, constants, standards, conversion factors
6039—Other (specify)

OTHER FIELDS OF SCIENCE

5350—Atmospheric Sciences
5760—Chemistry
5360—Earth Sciences

6210—Mathematics
6330—Computer Science
6350—Statistics

6590—Agricultural Science
6580—Biological and Biomedical Sciences

6790—Psychology
6900—Anthropology
7050—Economics
7160—Linguistics
7270—Political Science
7360—Sociology

9990—Other (specify)

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PT21 PRIMARY WORK ACTIVITY BY 2NDARY WORK ACT,EMPLOYER,SPECIALTY OF COMP, DEGREE      A1
DIMENSION-001  PHD
DIMENSION-002  1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: COLLEGE OR UNIVERSITY
                       ----- ----- SECON -DARY ACTI- VITY ----- ----- -----
                       BASIC APPL. DEVEL MANAG MANAG TEACH         NO
PRIM ACTIV              RES   RES  + DES  R+C  OTHER  -ING  OTHER RESP.  TOTAL

BASIC RES         N           197    48    88    15  2120    190   385   3043
                  H           6.5   1.6   2.9    .5  69.7    6.2  12.7  100.1
                  V          31.7  57.1  41.1   3.7  82.6   51.8  43.9   37.5
APPLIED RES       N      39     7    20    14         149     11    11  [illegible]
                  H    15.2   2.7   7.8   5.4        58.2    4.3   4.3   99.9
                  V     1.3   1.1  23.8   6.9         5.8    3.0   1.3    3.2
DEVEL+DESIGN      N       5     3     1     1     1     2                  13
                  H    38.5  23.1   7.7   7.7   7.7  15.4               100.1
                  V      .2    .5   1.2    .5    .2    .1                  .2
MANAG - R+D       N      58    34     2          18    81      9     9    211
                  H    26.9  12.0    .9         8.5  41.8    4.3   4.3  100.1
                  V     1.9   5.5   2.4         4.5   3.6    2.5   1.0    2.7
MANAG - OTHER     N      49     8     1    39        215      8    33    353
                  H    13.9   2.3    .3  11.0       60.9    2.3   9.3  100.0
                  V     1.6   1.3   1.2  18.2        8.3    2.2   3.8    4.3
TEACHING          N    2815   397    12    68   365         144   249   4028
                  H    69.9   9.9    .3   1.7   9.1         3.6   6.2  100.1
                  V    94.6  60.9  14.3  30.8  91.0        39.2  28.4   49.6
OTHER             N       9     2           1     1     7      5     7     32
                  H    28.1   6.3         3.1   3.1  21.9   15.6  18.8  100.1
                  V      .3    .3          .5    .2    .3    1.4    .8     .4
NO RESPONSE       N                                               184    184
                  H                                             100.0  100.0
                  V                                              21.0    2.3
TOTAL             N    2975   622    84   214   401  2585    367   877   8125
                  H    36.6   7.7   1.0   2.6   4.9  31.8    4.5  10.8   99.9
                  V    99.9 100.0 100.0 100.0  99.9 100.1  100.1 100.1  100.2

DIMENSION-001  PHD
DIMENSION-002  1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: PRIVATE INDUSTRY
BASIC RES         N           436    11    91     3    25     58   101    729      A2
                  H          59.8   1.5  12.5    .4   3.4    8.0  14.1  100.0
                  V          36.1   1.7  20.3   3.4  36.8   14.1  26.9   19.4
APPLIED RES       N     359   154   447   233     6    25    164    39   1468
                  H    24.5  10.5  30.4  15.9    .4   1.7   11.2   2.6  100.0
                  V    81.0  12.7  69.7  51.4   4.1  36.8   40.0  20.6   39.1
DEVEL+DESIGN      N       5   133    35    32     3     3     28    13    252
                  H     1.3  52.8  13.9  12.7   2.0   1.2   11.1   5.2  100.1
                  V     1.1  11.0   5.5   7.1   3.4   4.4    6.8   3.4    6.7
MANAG - R+D       N      70   437   124         124    11     65    74    904
                  H     7.7  48.3  13.7        13.7   1.3    7.2   8.2   99.9
                  V    15.8  36.2  19.3        82.4  17.6   15.9  19.3   24.1
MANAG - OTHER     N       1     5     8    81          3     47    23    167
                  H      .6   3.0   4.8  48.5        1.8   28.1  13.8  100.0
                  V      .2    .4   1.2  18.0        2.9   11.5   6.0    4.5
TEACHING          N       1     2          2                 2             7
                  H    14.3  28.6        28.6               28.6         100.1
                  V      .2    .2          .4                 .5             .2
OTHER             N       9    41    16    13    10     1     44    21    155
                  H     5.8  26.5  10.3   8.4   6.5    .6   28.4  13.5  100.0
                  V     2.0   3.4   2.5   2.9   6.8   1.5   10.7   5.5    4.1
NO RESPONSE       N                                                70     70
                  H                                             100.0  100.0
                  V                                              18.3    1.9
TOTAL             N     443  1208   641   451   148    68    410   383   3752
                  H    11.8  32.2  17.1  12.0   3.9   1.8   10.9  10.2   99.9
                  V    99.9 100.0  99.9 100.0 100.1 100.0  100.0 100.0  100.0
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0121 PRIMARY WORK ACTIVITY BY 2NDARY WORK ACT,EMPLOYER,SPECIALTY OF COPP, DEGREE A3
DIMENSION-001 PHD
DIMENSION-002 131 COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003 CPP: GOVERNMENT-FEDERAL ETC.

PRIM ACTIV		BASIC RES	APPL RES	DEVEL + DES	MANAG R+D	MANAG OTHER	TEACH -ING	OTHER	NO RESP.	TOTAL
BASIC RES	N		267	18	139	3	44	129	111	703
	H		[illegible]	2.6	[illegible]	.4	[illegible]	[illegible]	[illegible]	100.0
	V		63.[illegible]	28.6	62.[illegible]	7.[illegible]	69.[illegible]	[illegible]	[illegible]	48.5
APPLIED RES	N	98	[illegible]	31	56	1	[illegible]	41	15	276
	H	[illegible]	[illegible]	11.2	[illegible]	.4	[illegible]	[illegible]	5.4	100.0
	V	51.[illegible]	[illegible]	49.2	[illegible]	2.6	10.[illegible]	17.[illegible]	6.8	19.1
DEVEL+DESIGN	N	2	8		2			1		13
	H	15.4	61.5		15.4			7.7		100.0
	V	1.0	[illegible]		.9			.4		.9
MANAG - R+D	N	86	105	12		33	[illegible]	48	46	336
	H	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	100.0
	V	44.[illegible]	[illegible]	19.0		84.6	[illegible]	[illegible]	20.9	23.2
MANAG - OTHER	N	[illegible]	[illegible]	[illegible]	18		[illegible]	[illegible]	[illegible]	[illegible]
	H	2.[illegible]	[illegible]	[illegible]	39.[illegible]		[illegible]	32.[illegible]	[illegible]	100.0
	V	[illegible]	1.0	[illegible]	7.4		4.5	[illegible]	[illegible]	3.2
TEACHING	N	[illegible]	[illegible]					[illegible]		[illegible]
	H	50.0	25.0					25.0		100.0
	V	1.0	[illegible]					.4		.3
OTHER	N	[illegible]	[illegible]	[illegible]	7	[illegible]		[illegible]	[illegible]	34
	H	[illegible]	[illegible]	[illegible]	20.6	[illegible]		11.8	17.6	100.0
	V	1.6	[illegible]	1.6	3.2	[illegible]		1.7	[illegible]	2.3
NO RESPONSE	N								36	36
	H								100.0	100.0
	V								[illegible]	2.5
TOTAL	N	192	414	63	216	39	66	238	220	1448
	H	[illegible]	[illegible]	4.4	[illegible]	2.7	4.6	[illegible]	[illegible]	100.1
	V	99.9	100.1	100.0	99.9	100.0	100.0	100.0	100.0	100.0

DIMENSION-001 PHD
DIMENSION-002 131 COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003 CPP: RESEARCH CENTERS A4

BASIC RES	N		259	31	121	3	60	131	192	873
	H		30.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.0
	V		51.[illegible]	24.[illegible]	56.[illegible]	10.0	73.[illegible]	[illegible]	[illegible]	44.3
APPLIED RES	N	153	[illegible]	[illegible]	[illegible]	1	14	[illegible]	28	529
	H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	99.9
	V	52.[illegible]	[illegible]	[illegible]	38.[illegible]	5.0	17.[illegible]	[illegible]	[illegible]	30.2
DEVEL+DESIGN	N	15	30	11	[illegible]			[illegible]	[illegible]	63
	H	21.5	46.[illegible]	16.[illegible]	6.2			4.6	4.6	100.0
	V	[illegible]	[illegible]	[illegible]	1.9			[illegible]	[illegible]	[illegible]
MANAG - R+D	N	101	133	25		15	7	[illegible]	34	345
	H	[illegible]	[illegible]	7.2		[illegible]	[illegible]	[illegible]	[illegible]	100.0
	V	34.[illegible]	26.[illegible]	12.0		75.0	[illegible]	11.4	11.3	[illegible]
MANAG - OTHER	N	[illegible]	[illegible]	2	3		[illegible]	[illegible]	[illegible]	17
	H	11.[illegible]	17.6	[illegible]	17.6		[illegible]	[illegible]	11.[illegible]	100.0
	V	.7	.6	1.0	1.4		1.2	1.5	.7	.9
TEACHING	N									
	H									
	V									
OTHER	N	21	13	2	4	2		2	[illegible]	52
	H	40.[illegible]	25.0	[illegible]	7.[illegible]	3.[illegible]		3.[illegible]	13.[illegible]	99.9
	V	7.2	2.6	1.0	1.9	10.0		.8	2.[illegible]	2.9
NO RESPONSE	N								34	34
	H								100.0	100.0
	V								[illegible]	[illegible]
TOTAL	N	291	496	209	214	20	82	265	301	1877
	H	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.4	[illegible]	16.0	100.0
	V	100.0	99.9	100.2	100.0	[illegible]	100.0	100.1	100.1	100.1

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0T21 PRIMARY WORK ACTIVITY BY 2NDARY WORK ACT,EMPLOYER,SPECIALTY OF COMP, DEGREE A5
DIMENSION-001  PHD
DIMENSION-002  1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: OTHER KNOWN
                        ----- ----- SECON -DARY ACTI- VITY ----- ----- -----
                        BASIC APPL. DEVEL MANAG MANAG TEACH       NO
PRIM ACTIV                RES   RES + DES   R+D OTHER  -ING OTHER RESP. TOTAL
BASIC RES          N             60    10    31     3    50    35    63   252
                   H           23.8   4.0  12.3   1.2  19.8  13.9  25.0 100.0
                   V           38.7  18.5  39.2   6.4  45.0  28.0  39.9  30.9
APPLIED RES        N       43    10    20    25     2    27    25     5   157
                   H     27.4   6.4  12.7  15.9   1.3  17.2  15.9   3.2 100.0
                   V     50.0   6.5  37.0  31.6   4.3  24.3  20.0   3.2  19.3
DEVEL+DESIGN       N        3     7     4     2           1     3     1    21
                   H     14.3  33.3  19.0   9.5         4.8  14.3   4.8 100.0
                   V      3.5   4.5   7.4   2.5          .9   2.4    .6   2.6
MANAG - R+D        N       11    44     3          16     6    12     8   100
                   H     11.0  44.0   3.0        16.0   6.0  12.0   8.0 100.0
                   V     12.8  28.4   5.6        34.0   5.4   9.6   5.1  12.3
MANAG - OTHER      N        4     5     7    12          17    23    12    80
                   H      5.0   6.3   8.8  15.0        21.3  28.8  15.0 100.2
                   V      4.7   3.2  13.0  15.2        15.3  18.4   7.6   9.8
TEACHING           N       19    11           3    14          13    22    82
                   H     23.2  13.4         3.7  17.1        15.9  26.8 100.1
                   V     22.1   7.1         3.8  29.8        10.4  13.9  10.1
OTHER              N        6    18    10     6    12    10    14    31   107
                   H      5.6  16.8   9.3   5.6  11.2   9.3  13.1  29.0  99.9
                   V      7.0  11.6  18.5   7.6  25.5   9.0  11.2  19.6  13.1
NO RESPONSE        N                                                16    16
                   H                                             100.0 100.0
                   V                                              10.1   2.0
TOTAL              N       86   155    54    79    47   111   125   158   815
                   H     10.6  19.0   6.6   9.7   5.8  13.6  15.3  19.4 100.0
                   V    100.1 100.0 100.0  99.9 100.0  99.9 100.0 100.0 100.1
DIMENSION-001  PHD
DIMENSION-002  1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: NO RESPONSE
BASIC RES          N                                      1                 1
                   H                                  100.0             100.0    A6
                   V                                   33.3                .3
APPLIED RES        N
                   H
                   V
DEVEL+DESIGN       N
                   H
                   V
MANAG - R+D        N              1                                         1
                   H          100.0                                     100.0
                   V          100.0                                        .3
MANAG - OTHER      N                                      1                 1
                   H                                  100.0             100.0
                   V                                   33.3                .3
TEACHING           N        1                       1                       2
                   H     50.0                    50.0                   100.0
                   V    100.0                   100.0                      .5
OTHER              N                                      1           1     2
                   H                                   50.0        50.0 100.0
                   V                                   33.3          .3    .5
NO RESPONSE        N                                                376   376
                   H                                              100.0 100.0
                   V                                               99.7  98.2
TOTAL              N        1     1             1     3         377   383
                   H       .3    .3            .3    .8        98.4 100.0
                   V    100.0 100.0         100.0  99.9       100.0 100.1
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0T21 PRIMARY WORK ACTIVITY BY 2NDARY WORK ACT,EMPLOYER,SPECIALTY OF COMP, DEGREE A7
DIMENSION-001 NO PHD
DIMENSION-002 1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: COLLEGE OR UNIVERSITY

PRIM ACTIV		BASIC RES	APPL RES	DEVEL + DES	MANAG R+D	MANAG OTHER	TEACH -ING	OTHER	NO RESP.	TOTAL
		SECON-	-DARY	ACTI-	VITY					
BASIC RES	N		362	118	20	4	410	433	357	2304
	H		15.7	5.1	.9	.2	17.8	18.8	15.5	100.1
	V		61.0	48.4	36.4	2.0	84.0	61.0	48.3	45.3
APPLIED RES	N	79	21	47	16	2	71	61	45	343
	H	23.2	6.1	13.7	4.7	.6	20.7	17.8	14.2	100.1
	V	11.4	3.6	19.3	29.1	1.0	7.3	8.6	3.6	6.7
DEVEL+DESIGN	N	15	13	11	1		6	9	4	61
	H	24.6	19.7	21.3	1.3		9.8	14.8	6.6	100.1
	V	2.2	2.0	5.3	3.6		.6	1.3	.2	1.2
MANAG - R+D	N	6	19	8		2	9	7	4	55
	H	10.9	34.5	14.5		3.6	16.4	12.7	7.3	99.9
	V	.9	3.2	3.3		1.0	.9	1.0	.2	1.1
MANAG - OTHER	N	2	2	1	1		46	7	6	65
	H	6.2	6.2	3.1	1.5		92.3	14.6	12.3	100.0
	V	.3	.3	.4	1.8		4.3	1.0	.4	1.0
TEACHING	N	436	145	44	15	193		148	648	1764
	H	24.7	8.2	2.5	.9	11.0		8.4	36.7	100.1
	V	65.4	24.4	18.0	27.3	94.1		20.8	39.3	34.6
OTHER	N	40	21	9	1	4	14	9	23	121
	H	33.1	17.4	7.4	.8	3.3	11.6	7.4	19.0	100.0
	V	6.0	3.6	3.7	1.8	2.0	1.4	1.3	1.4	2.4
NO RESPONSE	N								423	423
	H								100.0	100.0
	V								25.6	8.3
TOTAL	N	667	594	244	55	205	978	710	1650	5097
	H	13.1	11.7	4.8	1.1	4.0	19.2	13.9	32.4	100.0
	V	100.0	99.9	100.0	100.0	100.1	100.0	100.1	100.0	100.0

DIMENSION-001 NO PHD
DIMENSION-002 1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: PRIVATE INDUSTRY A8

PRIM ACTIV		BASIC RES	APPL RES	DEVEL + DES	MANAG R+D	MANAG OTHER	TEACH -ING	OTHER	NO RESP.	TOTAL
BASIC RES	N		103	22	11		6	32	14	190
	H		54.2	11.6	5.8		3.2	16.8	7.4	100.0
	V		7.4	1.6	2.6		8.5	3.4	3.3	3.7
APPLIED RES	N	129	304	711	170	21	15	326	72	1749
	H	1.4	17.4	40.7	9.7	1.2	.9	18.6	4.1	100.1
	V	81.1	21.7	46.4	39.4	10.4	21.1	34.2	16.9	33.6
DEVEL+DESIGN	N	8	464	356	93	28	9	144	65	1167
	H	.7	39.8	30.5	8.0	2.4	.8	12.3	5.6	100.1
	V	5.0	33.2	23.1	21.6	13.9	12.7	15.1	14.5	22.4
MANAG - R+D	N	10	318	249		82	4	123	64	853
	H	1.2	37.4	29.2		9.6	.5	14.4	7.5	100.0
	V	6.3	22.8	16.3		40.8	5.6	12.9	14.3	16.4
MANAG - OTHER	N	1	70	96	119		10	163	50	510
	H	.2	13.7	18.8	23.3		2.0	32.0	9.8	100.0
	V	.6	5.0	6.3	27.6		15.9	17.1	11.7	9.8
TEACHING	N	1	1	1		3		9	2	17
	H	5.9	5.9	5.9		17.6		52.9	11.8	100.0
	V	.6	.1	.1		1.5		.9	.4	.3
OTHER	N	10	138	107	36	66	24	155	110	646
	H	1.5	21.4	16.6	5.6	10.2	3.7	24.0	17.0	100.0
	V	6.3	9.9	8.9	8.4	32.8	33.8	16.3	34.6	12.4
NO RESPONSE	N								70	70
	H								100.0	100.0
	V								15.7	1.3
TOTAL	N	159	1398	1542	431	201	71	952	427	5205
	H	3.1	26.9	29.6	8.3	3.9	1.4	18.3	8.2	100.1
	V	99.9	100.1	99.9	100.0	99.9	100.1	99.9	99.9	99.9

0723 PRIMARY WORK ACTIVITY BY 2NDARY WORK ACT,EMPLOYER,SPECIALTY OF COMP, DEGREE A9
DIMENSION-001 NO PHD
DIMENSION-002 1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: GOVERNMENT-FEDERAL ETC.

PRIM ACTIV		BASIC RES	APPL RES	DEVEL + DES	MANAG R+D	MANAG OTHER	TEACH -ING	OTHER	NO RESP.	TOTAL
		SECONDARY	-DARY	ACTI-	VITY					
BASIC RES	N		194	33	37	4	10	47	39	409
	H		47.4	8.1	9.0	1.0	2.4	11.5	9.5	99.9
	V		25.2	7.6	17.4	4.5	31.3	15.0	17.7	16.4
APPLIED RES	N	148	190	260	118	11	11	146	46	950
	H	15.6	20.0	27.4	12.4	1.2	1.2	15.4	4.8	100.0
	V	68.2	24.7	59.9	55.4	12.4	34.4	38.1	20.9	38.2
DEVEL+DESIGN	N	10	88	47	23	4	1	27	6	206
	H	4.9	42.7	22.8	11.2	1.9	.5	13.1	2.9	100.0
	V	4.6	11.4	10.8	10.8	4.5	3.1	8.6	2.7	8.3
MANAG - R+D	N	35	235	64		41	3	61	37	476
	H	7.4	49.4	13.4		8.6	.6	12.8	7.8	100.0
	V	16.1	30.6	14.7		46.1	9.4	19.4	16.8	19.1
MANAG - OTHER	N		23	11	21		2	61	15	133
	H		17.3	8.3	15.8		1.5	45.9	11.3	100.0
	V		3.0	2.5	9.9		6.3	19.4	6.8	5.3
TEACHING	N	1		1		4		5	3	14
	H	7.1		7.1		28.6		35.7	21.4	99.9
	V	.5		.2		4.5		1.6	1.4	.6
OTHER	N	23	69	18	14	24	5	68	32	253
	H	9.1	27.3	7.1	5.5	9.5	2.0	26.9	12.6	100.0
	V	10.6	9.0	4.1	6.6	27.0	15.6	21.7	14.5	10.2
NO RESPONSE	N								45	45
	H								100.0	100.0
	V								20.5	1.8
TOTAL	N	217	769	434	213	89	32	314	220	2488
	H	8.7	30.9	17.4	8.6	3.6	1.3	12.6	8.8	100.0
	V	100.0	100.0	99.8	100.1	100.1	100.1	100.1	100.0	100.0

DIMENSION-001 NO PHD
DIMENSION-002 1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: RESEARCH CENTER A10

PRIM ACTIV		BASIC RES	APPL RES	DEVEL + DES	MANAG R+D	MANAG OTHER	TEACH -ING	OTHER	NO RESP.	TOTAL
BASIC RES	N		64	16	8		20	67	57	232
	H		27.6	6.9	3.4		8.6	28.9	24.6	100.0
	V		27.7	9.6	16.7		66.7	37.0	50.0	27.3
APPLIED RES	N	38	47	80	27	1	4	50	15	263
	H	14.5	17.9	30.4	10.3	.4	1.5	19.0	5.7	100.0
	V	65.5	20.3	48.2	56.3	4.3	13.3	27.6	13.2	30.9
DEVEL+DESIGN	N	4	43	33	1			22	3	106
	H	3.8	40.6	31.1	.9			20.8	2.8	100.0
	V	6.9	18.6	19.9	2.1			12.2	2.6	12.5
MANAG - R+D	N	4	45	20		10		19	11	108
	H	3.7	41.7	18.5		9.3		17.6	10.2	100.1
	V	6.9	19.5	12.0		43.5		10.5	9.6	12.7
MANAG - OTHER	N		6	9	8		4	12	3	42
	H		14.3	21.4	19.0		9.5	28.6	7.1	99.9
	V		2.6	5.4	16.7		13.3	6.6	2.6	4.9
TEACHING	N		1			1		1	1	4
	H		25.0			25.0		25.0	25.0	100.0
	V		.4			4.3		.6	.9	.5
OTHER	N	12	25	8	4	10	2	11	11	83
	H	14.5	30.1	9.6	4.8	12.0	2.4	13.3	13.3	100.0
	V	20.7	10.8	4.8	8.3	43.5	6.7	6.1	9.6	9.8
NO RESPONSE	N								13	13
	H								100.0	100.0
	V								11.4	1.5
TOTAL	N	58	231	166	48	23	30	181	114	851
	H	6.8	27.1	19.5	5.6	2.7	3.5	21.3	13.4	99.9
	V	100.0	99.9	99.9	100.1	100.0	100.0	100.0	99.9	100.1

```
0721 PRIMARY WORK ACTIVITY BY 2NDARY WORK ACT,EMPLOYER,SPECIALTY OF COMP, DEGREE A11
DIMENSION-001  NO PHD
DIMENSION-002  1ST COMP: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: OTHER KNOWN
                        -----  -----  SECON  -DARY  ACTI-  VITY   -----  -----  -----
                        BASIC  APPL   DEVEL  MANAG  MANAG  TEACH         NO
PRIM ACTIV                RES    RES  + DES    R+D  OTHER  -ING   OTHER  RESP.  TOTAL
BASIC RES          N              29      5      6      2     15     30     29    116
                   H            25.0    4.3    5.2    1.7   12.9   25.9   25.0  100.0
                   V             9.8    3.5    8.5     .5    8.0    7.1    1.9    3.4
APPLIED RES        N       21     39     40     31      3     24     61     22    237
                   H      8.9   16.5   16.9   13.1    1.3   10.1   25.7    9.3  100.0
                   V     16.4   13.4   28.4   44.3     .7   12.8   10.6    1.4    7.0
DEVEL+DESIGN       N        1     13      4      6      2      2     12      4     44
                   H      2.3   29.5    9.1   13.6    4.5    4.5   27.3    9.1   99.9
                   V       .8    4.4    2.8    8.6     .5    1.1    2.1     .3    1.3
MANAG - R+D        N        8     68     11            32     12     41     14    181
                   H      4.4   37.6    6.1          17.8    6.6   22.7    7.7  100.0
                   V      6.3   22.3    7.8           7.5    6.4    7.1     .9    5.4
MANAG - OTHER      N              22     10     12           110     63     70    287
                   H             7.7    3.5    4.2          38.3   22.0   24.4  100.1
                   V             7.4    7.1   17.1          58.5   10.9    4.6    8.5
TEACHING           N       85    102     55      5    371           326   1181   2135
                   H      4.0    4.8    2.6     .2   17.4          15.3   55.3  100.0
                   V     66.4   34.9   39.0    7.1   86.7          56.6   76.7   63.5
OTHER              N       13     29     16     10     21     20     41     85    235
                   H      5.5   12.3    6.8    4.3    8.9    8.5   17.4   36.2  100.0
                   V     10.2    9.9   11.3   14.3    4.9   10.6    7.1    5.5    7.0
NO RESPONSE        N                                                       118    118
                   H                                                     100.0  100.0
                   V                                                       7.7    3.5
TOTAL              N      128    292    141     70    428    188    576   1539   3363
                   H      3.8    8.7    4.2    2.1   12.7    5.6   17.1   45.8   99.9
                   V    100.1  100.0   99.9  100.0  100.1  100.0  100.0  100.0   99.9
DIMENSION-001  NO PHD
DIMENSION-002  1ST COMP: TOTAL ALL PANEL GROUPS                                          A12
DIMENSION-003  EMP: NO RESPONSE
BASIC RES          N               4                         2                          6
                   H            66.7                      33.3                      100.0
                   V            80.0                     100.0                         .3
APPLIED RES        N
                   H
                   V
DEVEL+DESIGN       N
                   H
                   V
MANAG - R+D        N
                   H
                   V
MANAG - OTHER      N               1                                                    1
                   H           100.0                                                100.0
                   V            20.0                                                   .0
TEACHING           N        1                                                    1      2
                   H     50.0                                                 50.0  100.0
                   V    100.0                                                   .0     .1
OTHER              N
                   H
                   V
NO RESPONSE        N                                                          2017   2017
                   H                                                         100.0  100.0
                   V                                                         100.0   99.6
TOTAL              N        1      5                         2                2018   2026
                   H       .0     .2                        .1                99.6   99.9
                   V    100.0  100.0                     100.0               100.0  100.0
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DIMENSION-00| PHD
DIMENSION-00| EMP: COLLEGE OR UNIVERSITY
DIMENSION-00| PRIMARY ACTS TOTAL KNOWN

A15

PAN1:4 E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2:6 N E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4:N P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5A:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5B:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5P E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6:C M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7:S E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8:BIO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9:OPTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-19:ASTRON	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE TOTAL KNOWN	100.0	103.6	100.3	100.1	174.4	102.8	105.6	101.9	102.6	101.5	101.1	100.0	100.6	102.4	104.4	[illegible]

DIMENSION-00| PHD
DIMENSION-00| EMP: PRIVATE INDUSTRY
DIMENSION-00| PRIMARY ACTS TOTAL KNOWN

A16

PAN1:4 E P	71.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2:6 N E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4:N P	12.5	[illegible]	11.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5A:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5B:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5P E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6:C M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7:S E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8:BIO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9:OPTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-19:ASTRON	[illegible]	[illegible]	3.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE TOTAL KNOWN	100.1	102.1	100.0	102.0	174.0	105.2	178.1	101.3	104.3	99.0	103.4	104.8	104.3	104.7	109.1	107.1

A17

DIMENSION-001 PHD
DIMENSION-002 EMP: GOVERNMENT-FEDERAL ETC.
DIMENSION-003 PRIMARY ACT: TOTAL KNOWN

PAN1:A C R	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2:A M E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4:N P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5A:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5B:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5:P C P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6:C M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7:S C P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8:BIO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9:OPTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-15:ASTRON	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE	21	[illegible]	43	10	49	46	9	17	149	23	10	59	10	19	33	[illegible]
TOTAL KNOWN	104.9	103.1	102.2	94.9	163.1	183.5	173.1	101.2	102.8	100.0	102.1	103.5	100.8	100.9	103.0	107.2

A18

DIMENSION-001 PHD
DIMENSION-002 EMP: RESEARCH CENTER
DIMENSION-003 PRIMARY ACT: TOTAL KNOWN

PAN1:A C R	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2:A M E	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4:N P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5A:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5B:P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5:P C P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6:C M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7:S C P	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8:BIO	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9:OPTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-15:ASTRON	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE	22	100	22	40	74	13	20	36	9	23	8	1	49	20	31	[illegible]
TOTAL KNOWN	99.9	104.0	94.9	100.1	162.4	190.3	180.1	102.8	104.4	104.0	104.8	100.0	104.1	103.4	106.2	111.1

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DIMENSION-001 PHD
DIMENSION-002 EMP: OTHER KNOWN
DIMENSION-003 PRIMARY ACTI TOTAL KNOWN

PAN11A E R																	
PAN2IA F E	N V	6 100.0			1 .8					2 8.3					[illegible]		10 1.3
PAN3IE P	N V		10 75.0		4 3.2	1 6.7	1 5.6	2 6.1	4 3.4		3 4.5	1 2.2		1 3.2	[illegible]	2 5.4	58 7.6
PAN4IN P	N V			27 84.4	4 3.2				4 3.4		1 1.5				[illegible]	1 2.7	47 6.2
PAN5AIP	N V		1 2.5	2 6.3	98 79.0	1 6.7	1 5.6	2 6.1	5 4.2	3 12.5	5 7.6			1 3.2	19 [illegible]	3 8.1	136 17.8
PAN5DIP	N V		1 2.5			10 66.7		10 30.3	3 2.5		1 1.5				[illegible]		27 [illegible]
PAN5IP E F	N V			1 3.1	1 .8		16 88.9	16 48.5		1 4.2					[illegible]	2 [illegible]	23 3.0
PAN6IC M	N V		1 2.5	1 3.1	1 .8	10 66.7	16 88.9	26 78.8	3 2.5	1 4.2	1 1.5				[illegible]	2 5.4	45 5.9
PAN7IS E P	N V		2 5.0	1 3.1	5 4.0	2 13.3		2 6.1	87 73.7	2 8.3	9 13.6	10 22.2	1 6.7	1 3.2	[illegible] 14.0	5 13.5	[illegible]
PAN8ISIO	N V		1 2.5						1 .8	9 37.5	2 3.0	3 6.7		4 12.9	1 .5	1 2.7	21 2.8
PAN9IOPTICS	N V		1 2.5		6 4.8						37 56.1	1 2.2	2 13.3		[illegible]		50 6.6
PAN10IACOUSTICS	N V		4 10.0		2 1.6				9 7.6	1 4.2	3 4.5	26 57.8			[illegible]	4 10.8	59 7.7
PAN11-15IASTRON	N V												10 66.7		[illegible]		13 1.7
PAN16IMISC	N V									4 16.7	1 1.5			24 77.4	[illegible]		34 4.5
NO RESPONSE	N V			1 3.1	3 2.4	1 6.7		1 3.0	5 4.2	2 8.3	4 6.1	4 8.9	2 13.3		[illegible]	19 51.4	139 18.2
TOTAL KNOWN	N V	8 100.0	40 102.5	32 103.1	124 100.6	15 166.8	18 189.0	33 178.9	118 102.3	24 104.2	66 101.4	45 100.0	15 100.0	31 99.9	[illegible] 104.6	37 105.4	[illegible]

0T3 SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE
DIMENSION-001 PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACT: BASIC RESEARCH

SUBFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL. PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1IA G R	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2IA M E	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3IL P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4IN P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5AIP	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5BIP	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5IP G F	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6IC M	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7IS G P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8IBIO	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9IOPTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10IACOUSTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-15IASTRON	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16IMISC	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE	N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL KNOWN	N %	[illegible] 100.0	[illegible] 101.1	[illegible] 100.1	[illegible] 100.2	[illegible] 147.7	[illegible] 152.6	[illegible] 102.9	[illegible] 101.7	[illegible] 102.7	[illegible] 101.8	[illegible] 102.2	[illegible] 102.5	[illegible] 101.3	[illegible] 101.7	[illegible] 105.9	[illegible] 106.9

DIMENSION-001 PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACT: APPLIED RESEARCH

SUBFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL. PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1IA G R	N %	[illegible] 28.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2IA M E	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3IE P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4IN P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5AIP	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5BIP	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5IP G F	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6IC M	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7IS G P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8IBIO	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9IOPTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10IACOUSTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-15IASTRGN	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16IMISC	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE	N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL KNOWN	N %	7 114.4	145 105.5	45 102.1	250 101.2	153 173.3	111 185.6	[illegible] 178.3	[illegible] 102.2	131 103.4	[illegible] 100.0	[illegible] 103.4	103 104.0	49 101.9	[illegible] 103.6	37 113.4	[illegible]

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#T3 SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE

A22

DIMENSION-001 PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACT: DEVEL + DESIGN

SUPFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL. PANEL 8	SPEC. PANEL 9	PANEL 10	PANEL 11-13	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1:A E R	V														1.3		2.3
PAN2:M E	V		61.1	6.3		8.3	33.3	13.3	3.1				6.3	12.5	6.7		6.7
PAN3:E P	V			62.5	31.3				2.1	20.0					2.7		9.3
PAN4:N P	V			25.0	64.4	16.7		13.3	4.2	10.0	50.0	3.6		12.5	5.3	25.0	13.1
PAN5A:P	V					58.3		46.7	2.1			7.1			2.7		3.6
PAN5B:P	V						66.7	13.3				1.8			2.7		1.9
PAN5:P E P	V					58.3	66.7	60.0	2.1			5.4			5.3		5.0
PAN6:C M	V	100.0	16.7			16.7		13.3	75.0	20.0	25.0	14.3	25.0		17.3	50.0	24.4
PAN7:S E P	V									70.0		1.8			4.0		1.9
PAN8:BIO	V										25.0						
PAN9:OPTICS	V		33.3						9.4			64.3		12.5	6.7		14.4
PAN10:ACOUSTICS	V								2.1				62.5				3.3
PAN11-15:ASTRON	V									10.0				50.0	1.3		1.9
PAN16:MISC	V			6.3	4.4				6.3	20.0		10.7	6.3	12.5	49.3	25.0	15.6
NO RESPONSE																	
TOTAL KNOWN	N	1	18	16	45	12	3	15	96	10	4	56	16	8	75	4	160
	V	100.0	100.0	100.1	99.9	150.3	166.7	159.9	102.2	100.0	100.0	105.5	100.1	100.0	105.3	100.0	105.1

DIMENSION-001 PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACT: MANAG -- R+D

A23

SUPFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL. PANEL 8	SPEC. PANEL 9	PANEL 10	PANEL 11-13	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1:A E R	V	81.8			.5									6.0	2.4	1.1	1.6
PAN2:M E	V		48.7	5.9	1.6	4.2	1.4	3.2	3.9	2.0	4.8	8.0		1.5	5.6	4.6	6.1
PAN3:E P	V		1.3	72.1	3.6							2.0	1.5	1.5	2.4	2.3	4.8
PAN4:N P	V		9.0	19.1	78.0	2.8	1.4	2.4	2.8	7.8	14.3	4.0			7.3	5.7	13.0
PAN5A:P	V				.5	70.8		41.1	1.0	2.0		2.5	2.9		3.8	3.4	4.9
PAN5B:P	V		2.6		.5	4.2	80.2	30.7		2.0		.5		3.0	1.3	2.3	3.4
PAN5:P E P	V		2.6		1.1	75.0	80.3	79.8	1.6	3.9		3.0	2.9	3.0	4.9	5.7	8.0
PAN6:C M	V	18.2	14.1		5.3	6.9	5.6	6.5	78.6	3.9	20.0	21.4	10.3	1.5	16.0	18.4	27.0
PAN7:S E P	V			1.5	.5	1.4		.8	.5	53.9	4.8	1.5		10.4	2.2	3.4	4.5
PAN8:BIO	V				.5						20.0		2.9			1.1	.3
PAN9:OPTICS	V		21.8		.5		1.4	.8	7.4	7.8		50.2	4.4	1.5	6.9	5.7	10.7
PAN10:ACOUSTICS	V					1.4		.8	.7	1.0	9.5	2.0	72.1		1.6		5.4
PAN11-15:ASTRON	V		1.3			1.4		.8		8.8	4.8			65.7		3.4	3.3
PAN16:MISC	V		1.3	1.5	5.3	6.9	1.4	4.8	3.9	10.8	4.8	8.0	5.9	9.0	91.0	48.3	16.9
NO RESPONSE																	
TOTAL KNOWN	N	11	78	68	189	72	9	124	435	102	21	201	68	67	450	87	1114
	V	100.0	102.7	100.1	100.9	175.0	186.4	179.7	101.7	103.9	100.3	103.1	102.9	103.1	104.9	105.4	107.0

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071 SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE

DIMENSION-001 PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACT: MANAG — OTHER

SUBFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	UN- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1:A E R	66.7													[illegible]		[illegible]
PAN2:A M E		57.1						[illegible]			[illegible]			[illegible]	[illegible]	[illegible]
PAN3:E P		[illegible]	60.[illegible]	[illegible]				[illegible]		25.0	[illegible]			[illegible]	[illegible]	[illegible]
PAN4:N P		9.5	[illegible]	81.0	16.[illegible]		11.[illegible]	[illegible]			6.5	16.7		10.[illegible]	[illegible]	15.[illegible]
PAN5A:F					50.0		33.[illegible]	1.0						[illegible]	[illegible]	[illegible]
PAN5B:P						100.0	33.3								[illegible]	[illegible]
PAN5:P & F					50.0	100.0	44.[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
PAN6:C M		23.8	12.5	3.2	33.[illegible]		22.[illegible]	76.[illegible]		25.0	16.1			10.[illegible]	10.0	26.[illegible]
PAN7:S & P									75.0				10.0	[illegible]		[illegible]
PAN8:BIO										50.0						
PAN9:OPTICS		4.8		[illegible]				7.[illegible]			61.3			[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS								1.0				66.7		[illegible]	1.0	[illegible]
PAN11-15:ASTRON									[illegible]				80.0	[illegible]		[illegible]
PAN16:MISC	33.[illegible]		12.5	[illegible]				7.[illegible]	16.[illegible]		3.2	16.7	10.0	48.5	54.5	28.[illegible]
NO RESPONSE TOTAL KNOWN	100.0	100.0	100.1	100.1	100.0	100.0	[illegible]	101.6	100.0	100.0	100.0	100.1	100.0	101.6	105.4	102.2

DIMENSION-001 PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACT: TEACHING

SUBFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	PANEL 5	PANEL 6	PANEL 7	PANEL 8	PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1:E C R	90.6												[illegible]	[illegible]		[illegible]
PAN2:A M E		70.[illegible]	[illegible]	1.0	[illegible]		[illegible]	[illegible]			11.[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	1.9	[illegible]	86.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]		1.[illegible]			[illegible]	[illegible]	[illegible]
PAN4:N P		4.6	3.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.[illegible]	3.[illegible]	2.[illegible]			[illegible]	[illegible]	[illegible]
PAN5A:F					80.[illegible]	[illegible]	90.[illegible]	1.0			[illegible]			[illegible]	2.[illegible]	[illegible]
PAN5B:P			[illegible]		[illegible]	82.[illegible]	[illegible]	[illegible]	2.[illegible]	1.[illegible]				[illegible]	2.[illegible]	[illegible]
PAN5:P & F			[illegible]		82.[illegible]	90.[illegible]	86.[illegible]	[illegible]	2.[illegible]	1.[illegible]				[illegible]	[illegible]	[illegible]
PAN6:C M		[illegible]	[illegible]	1.0	9.[illegible]		5.[illegible]	87.[illegible]	[illegible]	10.[illegible]	10.[illegible]	22.[illegible]	[illegible]	[illegible]	20.[illegible]	[illegible]
PAN7:S & P	1.0		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	70.[illegible]		[illegible]		3.0	1.[illegible]	2.[illegible]	[illegible]
PAN8:BIO										89.[illegible]	[illegible]	3.[illegible]		[illegible]	1.[illegible]	[illegible]
PAN9:OPTICS		10.[illegible]	1.1	[illegible]	[illegible]	[illegible]	[illegible]	2.[illegible]		5.0	94.[illegible]	[illegible]		[illegible]	2.[illegible]	[illegible]
PAN10:ACOUSTICS		[illegible]		[illegible]				[illegible]			[illegible]	84.[illegible]		[illegible]	1.[illegible]	[illegible]
PAN11-15:ASTRON	1.[illegible]								2.[illegible]		1.[illegible]		84.[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	3.[illegible]	4.[illegible]	4.[illegible]	4.[illegible]	4.[illegible]	3.[illegible]	4.[illegible]	[illegible]	7.[illegible]	11.[illegible]	6.[illegible]	3.[illegible]	3.[illegible]	30.[illegible]	42.[illegible]	21.[illegible]
NO RESPONSE TOTAL KNOWN	100.1	[illegible]	100.5	100.2	[illegible]	100.5	100.2	101.5	102.4	102.1	100.8	100.1	100.0	[illegible]	[illegible]	100.1

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OTS SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE

DIMENSION-001 PHD
DIMENSION-002 EMPT TOTAL KNOWN
DIMENSION-003 PRIMARY ACTS OTHER KNOWN

SUBFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB-PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1IA E & M	N V	100.0							4.3		20.0	14.3		10.0	[illegible]	12.5	[illegible]
PAN2IA M E	N V		45.5							10.5	20.0				[illegible]	[illegible]	[illegible]
PAN3IE P	N V			100.0	11.[illegible]				10.[illegible]	10.5		3.6			[illegible]	4.2	14.[illegible]
PAN4IN P	N V				85.7				2.2						1.[illegible]		2.[illegible]
PAN5AIP	N V					85.7		85.7					9.[illegible]		[illegible]		[illegible]
PAN5BIP	N V												5.[illegible]		2.[illegible]		[illegible]
PAN5IP E P	N V					85.7		85.7	2.[illegible]	5.[illegible]	20.0	14.[illegible]	5.[illegible]		10.[illegible]	16.[illegible]	16.[illegible]
PAN6IC M	N V		10.2		2.4				67.6	52.6		3.6		20.0	3.0	4.[illegible]	5.[illegible]
PAN7IS E P	N V								2.[illegible]		40.0						7.[illegible]
PAN8IBIO	N V								6.3	5.[illegible]		50.0		10.0	4.[illegible]	4.[illegible]	[illegible]
PAN9IOPTICS	N V		9.1										76.5		[illegible]	4.2	3.[illegible]
PAN10IACOUSTICS	N V								2.[illegible]	10.5				60.0	2.[illegible]		[illegible]
PAN11-15IASTRON	N V								4.[illegible]	5.[illegible]		14.[illegible]	11.8		54.[illegible]	50.0	2[illegible]
PAN16IMISC	N V		27.3			14.[illegible]		14.3									
NO RESPONSE TOTAL KNOWN	N V	100.0	100.1	100.0	100.0	185.7		185.7	102.2	100.0	100.0	100.1	106.0	100.0	102.5	100.2	101.5

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DIMENSION-001 PHD
DIMENSION-002 EMPT TOTAL KNOWN
DIMENSION-003 PRIMARY ACTS TOTAL KNOWN

		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB-PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1IA E & M	N V	200 62.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2IA M E	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3IE P	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4IN P	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5AIP	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5BIP	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5IP E P	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6IC M	N V	2.0	9.0	1.0	2.[illegible]	13.[illegible]	1.[illegible]	[illegible]	[illegible]	60.0	[illegible]	1.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7IS E P	N V	1.6	[illegible]	.3	[illegible]	.7	[illegible]	.5	[illegible]	[illegible]	55.[illegible]	[illegible]	2.0	[illegible]	[illegible]	[illegible]	1060
PAN8IBIO	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.0	3.0	52.[illegible]	[illegible]	3.1	[illegible]	[illegible]	[illegible]
PAN9IOPTICS	N V	[illegible]	10.[illegible]	[illegible]	[illegible]	1.3	1.2	1.2	[illegible]	[illegible]	1.[illegible]	[illegible]	69.6	[illegible]	[illegible]	1.[illegible]	[illegible]
PAN10IACOUSTICS	N V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-15IASTRON	N V	5.8	[illegible]	[illegible]	[illegible]	[illegible]	3.0	3.[illegible]	[illegible]	5.[illegible]	5.3	[illegible]	6.[illegible]	4.7	11.9	41.0	[illegible]
PAN16IMISC	N V	2.5	2.0	2.[illegible]	2.[illegible]	4.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	614	3158	344	15333
NO RESPONSE TOTAL KNOWN	N V	243 100.4	1016 101.6	1334 100.3	1692 100.5	543 174.0	302 140.1	1045 101.7	3066 101.9	611 103.3	263 101.4	1012 102.6	346 102.6	101.3	102.6	105.9	101.2

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DIMENSION-001  NO PHD                                                                A28
DIMENSION-002  EMPL COLLEGE OR UNIVERSITY
DIMENSION-003  PRIMARY ACTI TOTAL KNOWN
PAN11A E R          N   41   [illegible]
                    V   74.2 [illegible]
PAN21A M L          N   [illegible]
                    V   [illegible]
PAN31C P            N   [illegible]
                    V   [illegible]
PAN41N P            N   [illegible]
                    V   [illegible]
PAN5A1F             N   [illegible]
                    V   [illegible]
PAN5B1P             N   [illegible]
                    V   [illegible]
PAN51P E F          N   [illegible]
                    V   [illegible]
PAN61C M            N   [illegible]
                    V   [illegible]
PAN71S E P          N   [illegible]
                    V   [illegible]
PAN81BIO            N   [illegible]
                    V   [illegible]
PAN91OPTICS         N   [illegible]
                    V   [illegible]
PAN101ACOUSTICS     N   [illegible]
                    V   [illegible]
PAN11-151ASTRON     N   [illegible]
                    V   [illegible]
PAN161MISC          N   [illegible]
                    V   [illegible]
NO RESPONSE         N   [illegible]
TOTAL KNOWN         N   78    370   490   499   73    124   197   1059  210   46    213   70    173   1321  274   [illegible]
                    V   99.9  100.8 100.1 100.1 167.2 191.0 102.1 102.1 103.0 102.1 100.1 101.3 101.7 101.0 101.1 104.5
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DIMENSION-001  NO PHD                                                                A29
DIMENSION-002  EMPL PRIVATE INDUSTRY
DIMENSION-003  PRIMARY ACTI TOTAL KNOWN
PAN11A E R          N   1
                    V   100.0
PAN21A M E          N   [illegible]
                    V   [illegible]
PAN31C P            N   [illegible]
                    V   [illegible]
PAN41N P            N   [illegible]
                    V   [illegible]
PAN5A1F             N   [illegible]
                    V   [illegible]
PAN5B1P             N   [illegible]
                    V   [illegible]
PAN51P E F          N   [illegible]
                    V   [illegible]
PAN61C M            N   [illegible]
                    V   [illegible]
PAN71S E P          N   [illegible]
                    V   [illegible]
PAN81BIO            N   [illegible]
                    V   [illegible]
PAN91OPTICS         N   40    2     5     9     5     14    131   8     4     847   3     9     106   17    1169
                    V   27.4  6.7   2.4   6.1   16.7  7.9   11.0  6.3   14.8  72.9  1.0   14.8  6.8   13.5  23.4
PAN101ACOUSTICS     N   [illegible]
                    V   [illegible]
PAN11-151ASTRON     N   [illegible]
                    V   [illegible]
PAN161MISC          N   [illegible]
                    V   [illegible]
NO RESPONSE         N   [illegible]
TOTAL KNOWN         N   1     146   30    205   147   30    171   1191  126   27    1162  312   61    1563  126   [illegible]
                    V   100.0 100.8 100.0 101.5 165.3 173.3 164.8 101.7 101.7 103.6 101.1 101.2 103.3 102.0 103.4 [illegible]
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DIMENSION-001  NO PHD
DIMENSION-003  EMP: GOVERNMENT-FEDERAL ETC.
DIMENSION-005  PRIMARY ACT: TOTAL KNOWN
PAN112 C F        N  [illegible]
                  V
PAN219 M E        N  [illegible]
                  V
PAN31E P          N  [illegible]
                  V
PAN4IN P          N  [illegible]
                  V
PAN5AIP           N  [illegible]
                  V
PAN5RIP           N  [illegible]
                  V
PAN5IP C P        N  [illegible]
                  V
PAN6IC M          N  [illegible]
                  V
PAN7IS C P        N  [illegible]
                  V
PAN8IRIO          N  [illegible]
                  V
PAN9IOPTICS       N  [illegible]
                  V
PAN10IACOUSTICS   N  [illegible]
                  V
PAN11-15IASTRON   N  [illegible]
                  V
PAN16IMISC        N  [illegible]
                  V
NO RESPONSE       N  [illegible]
TOTAL KNOWN       N      9   105    11   156   103    99   14?   385   193    20   365   259   111   638    47  2346
                  V  111.1 103.7 100.0 101.8 167.0 176.9 104.0 101.9 101.4 105.0 102.0 101.4 102.7 104.0 100.0 10?.5
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DIMENSION-001  NO PHD
DIMENSION-003  EMP: RESEARCH CENTER
DIMENSION-005  PRIMARY ACT: TOTAL KNOWN
PAN1IA C 2        N  [illegible]
                  V
PAN2IA M E        N  [illegible]
                  V
PAN3IE P          N  [illegible]
                  V
PAN4IN P          N  [illegible]
                  V
PAN5AIP           N  [illegible]
                  V
PAN5RIP           N  [illegible]
                  V
PAN5IP C P        N  [illegible]
                  V
PAN6IC M          N  [illegible]
                  V
PAN7IS C P        N  [illegible]
                  V
PAN8IRIO          N  [illegible]
                  V
PAN9IOPTICS       N  [illegible]
                  V
PAN10IACOUSTICS   N  [illegible]
                  V
PAN11-15IASTRON   N  [illegible]
                  V
PAN16IMISC        N  [illegible]
                  V
NO RESPONSE       N  [illegible]
TOTAL KNOWN       N      9   ?4    73   217    30    26     6   135    28     6    57    15    32   164    17   621
                  V  100.0  99.9 100.0 100.6 153.1 104.5 100.0 105.8 103.6 100.0 100.0 100.0 103.? 101.7 100.0 106.4
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DIMENSION-001 NO PHD
DIMENSION-002 EMP: OTHER KNOWN
DIMENSION-003 PRIMARY ACT: TOTAL KNOWN

PAN1IA E K	100.0													[illegible]	1.	[illegible]
PAN2IA N E		99.		2.				0.1	2.	2.	7.			[illegible]	8.	[illegible]
PAN3IE P			50.	[illegible]	9.		3.				.			[illegible]	[illegible]	[illegible]
PAN4IN P		4.	16.	66.	5.		3.	4.0	7.	9.	.	1.	5.	3.0	5.	[illegible]
PAN5AIP				.	55.		30.	1.	2.6		.			.	.	[illegible]
PAN5BIP				.	5.	100.0	34.	.			1.			[illegible]	.	[illegible]
PAN5IP E P				1.	61.	100.0	73.	2.	2.		2.			[illegible]	[illegible]	[illegible]
PAN6IC M		27.	0.	3.	5.		3.	50.	5.	7.	16.	0.		[illegible]	0.	[illegible]
PAN7IS E P		2.			9.		3.		54.	4.	.		15.	1.	2.0	2.
PAN8IBIO				2.						41.	[illegible]			[illegible]	[illegible]	[illegible]
PAN9IOPTICS		9.		1.	11.		7.	11.	3.	9.	62.0	3.	5.	4.	5.	6.
PAN10IACOUSTICS				.				3.	1.	6.		80.		[illegible]	1.	2.
PAN11-15IASTRON		2.						1.	3.		.		73.	[illegible]	[illegible]	[illegible]
PAN16IMISC		9.	16.	0.	5.		3.	8.	10.	19.	7.	5.		[illegible]	71.	64.
NO RESPONSE TOTAL KNOWN	100.0	100.0	100.0	100.	161.	200.0	172.	102.	102.6	100.	102.	100.	100.	100.	100.6	101.

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OTS SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGRE. A33

DIMENSION-001 NO PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACTI BASIC RESEARCH

SUBFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1:A & A	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2:A M E	N %	[illegible]	[illegible]	[illegible]	[illegible]	1.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4:N P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5A:F	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5B:P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5:P & F	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6:C M	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7:E & P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8:BIO	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9:OPTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN11-15:ASTRON	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE TOTAL KNOWN	N %	[illegible] 100.0	[illegible] 101.1	460 100.1	[illegible] 100.5	[illegible] 163.0	[illegible] 109.5	[illegible] 174.6	[illegible] 102.4	226 103.1	[illegible] 101.8	[illegible] 102.4	[illegible] 101.8	[illegible] 100.9	[illegible] 103.6	84 101.1	[illegible] 106.5

DIMENSION-001 NO PHD A34
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACTI APPLIED RESEARCH

SUBFLD 1ST COMP		PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	PANEL 5	PANEL 6	PANEL 7	PANEL 8	PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1:A & A	N %	2 40.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN2:A M E	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN3:E P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4:N P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5A:F	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5B:P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5:P & F	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6:C M	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN7:E & P	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN8:BIO	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9:OPTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN10:ACOUSTICS	N %	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.4	[illegible]	83.0	[illegible]	[illegible]	6.0	[illegible]
PAN11-15:ASTRON	N %	2 40.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN16:MISC	N %	1 20.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NO RESPONSE TOTAL KNOWN	N %	5 100.0	141 102.1	36 100.0	247 100.4	161 168.3	46 180.4	207 170.9	754 101.8	158 100.6	28 100.0	725 100.9	277 101.9	85 105.9	817 103.1	67 101.6	3473 106.0

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1707

OTS SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE

A35

DIMENSION-001 NO PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACTI DEVEL + DESIGN

SUBFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-13	PANEL 14	NO RESP.	TOTAL KNOWN
PAN1IA E R	20.0												4.	.	2.	[illegible]
PAN2IA M E		47.		2.				8.	4.0	9.	3.	1.	12.5	1.	8.0	3.
PAN3IC P	20.	3.	37.	4.	2.		2.	.			.	1.		1.		1.
PAN4IK P	20.0		63.0	73.				.		9.	.	1.		2.	8.0	5.
PAN5AIP		2.		1.	73.	12.	63.	1.			.			1.		3.
PAN5BIP				1.		87.	13.	.			.			.		.
PAN5IP E P		2.		2.	73.	100.0	70.	2.			1.			1.		2.
PAN6IC M	20.0	16.	5.	7.	13.		10.	71.	8.	9.	10.0	7.	4.	8.	20.	21.
PAN7IS E P			3.0		2.		2.	.	40.0				8.	1.	2.	1.
PAN8IBIO										30.						
PAN9IOPTICS		25.0		3.	9.		4.	10.	8.	27.	75.	2.	9.	6.	19.	24.
PAN10IACOUSTICS								1.	4.		.	81.		1.	2.	5.
PAN11-13IASTRON		2.							12.0		1.	1.	54.	1.	2.	1.
PAN14IMISC	20.0	2.0	10.	8.	2.		2.	10.	14.0	9.	9.	4.	12.	74.	42.0	27.
NO RESPONSE TOTAL KNOWN	100.0	102.	105.0	102.	173.	200.0	178.	102.	100.0	100.	101.	100.	[illegible]	101.	100.	103.

A36

DIMENSION-001 NO PHD
DIMENSION-002 EMP: TOTAL KNOWN
DIMENSION-003 PRIMARY ACTI MANAG -- R+D

SUBFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-13	PANEL 14	NO RESP.	TOTAL KNOWN
PAN1IA E R	66.															
PAN2IA M E		55.		4.	2.	7.	3.	2.	1.	9.	4.			2.	9.	9.
PAN3IC P			39.					.			.			1.	3.	1.
PAN4IK P		4.	90.0	70.	2.		1.	2.	9.	9.	1.	.		.	10.	8.
PAN5AIP	33.			.	66.	7.	53.	2.	2.	11.0	.	1.	3.	2.		4.
PAN5BIP						71.	16.		1.						1.	.
PAN5IP E P	33.			.	66.	78.0	69.		4.	11.0	.	1.	3.	3.	1.0	4.
PAN6IC M		10.		4.	12.		4.	71.	1.		13.	7.		11.	11.	20.
PAN7IS E P				.				1.0	47.		.	.	22.	2.	3.	4.
PAN8IBIO				3.						35.		.				
PAN9IOPTICS		17.	7.	3.	2.	7.	3.	11.	11.	11.	6.	1.	14.	6.	11.	15.
PAN10IACOUSTICS		2.			2.		1.	2.	2.	3.	.	83.	3.	3.	3.	3.
PAN11-13IASTRON				.							1.		51.			
PAN14IMISC		10.	7.	8.	12.	7.	11.	4.	5.	23.	7.	3.	3.	64.	42.	34.
NO RESPONSE TOTAL KNOWN	133.	99.	99.	101.	104.	170.	[illegible]	10[illegible]	104.	111.	100.	101.	103.	103.	102.	104.

OT3 SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE

A37

DIMENSION-001 NO PHD
DIMENSION-002 EMPL TOTAL KNOWN
DIMENSION-003 PRIMARY ACTI PARAG -- OTHER

SUMFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	UP- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN11A E R																
PAN21A M E		50.0		2.				1.		33.3	2.6			2.	3.	[illegible]
PAN31E P			30.0	4.				.						[illegible]		[illegible]
PAN41N P		14.3		83.		25.0	6.	2.	4.					6.	6.	[illegible]
PAN5A1P					94.		40.	.			1.	2.1		.		1.
PAN5B1P						75.0	20.0							.	1.	[illegible]
PAN5IP E P					54.	75.0	40.				[illegible]	2.		[illegible]	[illegible]	[illegible]
PAN6IC N		14.3	10.	4.	9.		6.	68.3	12.		11.	6.3	8.	9.	11.	[illegible]
PAN7IS E P									41.		.		8.	.	3.	1.
PAN8IBIO				.						33.3	1.	2.1		[illegible]		[illegible]
PAN9IOPTICS		14.		.				19.	8.		70.			[illegible]	1.	[illegible]
PAN10IACOUSTICS								2.	8.		.	81.3		3.	3.	[illegible]
PAN11-15IASTRON									8.				50.	[illegible]	2.	[illegible]
PAN16IMISC		7.	33.	4.	36.		26.	8.	16.	33.3	2.	8.	25.	6.	67.	36.
NO RESPONSE TOTAL KNOWN		100.0	100.0	100.0	155.	175.0	140.	100.	100.0	99.	101.	102.	99.	100.	101.0	101.

DIMENSION-001 NO PHD
DIMENSION-002 EMPL TOTAL KNOWN
DIMENSION-003 PRIMARY ACTI TEACHING

A38

SUMFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	UP- PANEL 5	FIELD PANEL 6	OF PANEL 7	EMPL PANEL 8	SPEC PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN11A E R	92.								2.				7.	[illegible]	1.0	[illegible]
PAN21A M E		62.	7.					4.0	4.		19.			[illegible]	2.	[illegible]
PAN31C P		1.	78.			9.	3.				1.			[illegible]	[illegible]	[illegible]
PAN41N P		7.	3.	81.	7.		3.	3.	4.		2.		7.	[illegible]	4.	[illegible]
PAN5A1P					93.		71.	2.						.	1.0	[illegible]
PAN5B1P						78.	96.							[illegible]		[illegible]
PAN5IP E P					93.	78.	60.							[illegible]	[illegible]	[illegible]
PAN6IC N		9.	5.	1.	7.	9.	6.	9.			17.	10.		[illegible]	10.	[illegible]
PAN7IS E P				.				.	61.	8.	1.		3.	[illegible]	.	[illegible]
PAN8IBIO				.						90.	1.	10.		[illegible]	1.	[illegible]
PAN9IOPTICS	7.	8.	1.		7.		3.	4.	2.		40.	[illegible]		4.	3.	[illegible]
PAN10IACOUSTICS		1.		.				1.				65.		[illegible]	.	[illegible]
PAN11-15IASTRON													78.	[illegible]		[illegible]
PAN16IMISC		15.	3.	13.	22.	10.	13.	19.	25.	41.	11.	10.	7.	9.	72.	[illegible]
NO RESPONSE TOTAL KNOWN	100.0	100.0	100.0	100.0	155.	170.	140.	10.	100.0	100.0	100.0	100.0	99.	100.	101.1	101.3

071 SPEC OF EMP BY SPEC OF 1ST COMP BY EMPLOYER,PRIMARY WORK ACTIVITY,DEGREE

DIMENSION-001 NO PHD
DIMENSION-003 EMPL TOTAL KNOWN
DIMENSION-005 PRIMARY ACTI OTHER KNOWN

SUBFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	SUB-FIELD OF EMPL SPEC PANEL 5	PANEL 6	PANEL 7	PANEL 8	PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1IA G R	75.0										[illegible]		3.0	.		[illegible]
PA[illegible] M E		27.0		.				6.0	1.		6.	1.0	3.0	1.	9.	3.
[illegible] P			60.0					.	1.				3.0	1.	3.	1.
PAN4IM P		10.5	6.0	79.	7.		7.	4.	4.	10.0	1.	2.	3.0	4.	10.	12.
PAN5AIF				1.	23.		21.		3.		1.			.	1.	1.
PAN5BIP											.			.	1.	[illegible]
PAN5IP G F				2.	23.		21.		3.		2.			1.	2.	1.
PAN6IC M		13.0	4.0	5.	7.		7.	60.	4.		13.	1.		8.	14.	12.
PAN7IS G P		4.							57.0		1.		7.	1.	2.	4.
PAN8IBIO				1.						60.				[illegible]	1.	[illegible]
PAN9IOPTICS		27.0		2.	15.	100.0	21.	14.	3.	20.	63.	2.	2.	4.	10.	12.
PAN10IACOUSTICS									3.		1.	87.0		2.	1.	7.
PAN11-15IASTRON	25.0								7.				64.	[illegible]		2.
PAN16IMISC		13.0	26.	8.	46.		42.	12.	14.	10.	6.	4.	10.	71.	40.	34.
NO RESPONSE TOTAL KNOWN	100.0	100.0	100.0	102.1	123.2	100.0	121.3	100.0	103.0	100.0	102.0	99.9	100.1	101.5	102.7	101.5

DIMENSION-001 NO PHD
DIMENSION-003 EMPL TOTAL KNOWN
DIMENSION-005 PRIMARY ACTI TOTAL KNOWN

SUBFLD 1ST COMP	PANEL 1	PANEL 2	PANEL 3	PANEL 4	PANEL 5A	PANEL 5B	PANEL 5	PANEL 6	PANEL 7	PANEL 8	PANEL 9	PANEL 10	PANEL 11-15	PANEL 16	NO RESP.	TOTAL KNOWN
PAN1IA G R	77.0															[illegible]
PAN2IA M E		61.	[illegible]	1.	1.	.	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.0	[illegible]	[illegible]	[illegible]
PAN3IC P	4.0	[illegible]	80.	[illegible]	.	.	.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN4IM P	1.0	2.	6.	80.	[illegible]	1.	[illegible]	[illegible]	2.0	[illegible]	[illegible]	1.0	1.	[illegible]	7.0	[illegible]
PAN5AIF	1.0	1.0	.	.	63.	[illegible]	46.	[illegible]	1.	2.	.	1.	1.0	[illegible]	.	[illegible]
PAN5BIP		.		.	[illegible]	83.	32.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN5IP G F	1.0	[illegible]	[illegible]	[illegible]	63.	85.0	72.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN6IC M	3.0	11.	2.	4.	13.	1.0	10.	[illegible]	[illegible]	7.	14.	9.	2.	[illegible]	12.	[illegible]
PAN7IS G P		.	.	[illegible]	1.0	.	1.	[illegible]	65.	[illegible]	[illegible]	1.	[illegible]	[illegible]	2.0	[illegible]
PAN8IBIO				[illegible]				[illegible]	[illegible]	69.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PAN9IOPTICS	1.0	14.	1.0	1.	4.	4.0	4.	[illegible]	[illegible]	12.	80.	[illegible]	4.	[illegible]	[illegible]	[illegible]
PAN10IACOUSTICS		.		.	.		.	[illegible]	[illegible]	5.	[illegible]	82.0	[illegible]	[illegible]	1.	[illegible]
PAN11-15IASTRON	7.0	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64.	[illegible]	[illegible]	[illegible]
PAN16IMISC	4.0	[illegible]	[illegible]	6.	9.	4.	7.	[illegible]	10.	11.	[illegible]	[illegible]	7.	73.	59.0	31.
NO RESPONSE TOTAL KNOWN	101.0	101.2	100.2	100.9	104.0	105.7	172.9	102.0	102.2	101.0	101.1	101.5	102.0	101.0	101.2	104.1

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DIMENSION-001  PHD                                                                                    A41
DIMENSION-002  EMP SPEC1 PANEL GROUP 1 -- A & R
DIMENSION-003  EMP1 TOTAL KNOWN
BASIC RES      N    [illegible]
               V                   67.[illegible] 60.[illegible] 67.[illegible] 50.0  50.0  36.[illegible]  71.[illegible] 100.0  66.7      46.[illegible] 100.0
               MP   25= 30.1   50= 33.9   75= 39.1
APPLIED RES    N    [illegible]
               V                   2.[illegible]  2.[illegible]  3.[illegible]  2.[illegible]          14.[illegible]                 2.[illegible]
               MP   25= 31.4   50= 35.0   75= 40.0
DEVEL+DESIGN   N    [illegible]
               V                   2.[illegible]                                                  .[illegible]
               MP   25= 40.0   50= 42.0   75= 43.3
MANAG - R+D    N    [illegible]
               V                   3.[illegible]  17.[illegible]  7.[illegible]  18.[illegible]        4.[illegible]
               MP   25= 39.5   50= 42.0   75= 44.5
MANAG - OTHER  N    [illegible]
               V                   2.[illegible]        9.[illegible]        33.[illegible]          1.[illegible]
               MP   25= 43.3   50= 52.0   75= 65.0
TEACHING       N    [illegible]
               V                   2.[illegible]  30.[illegible]  21.[illegible]  20.[illegible]  25.[illegible]  18.[illegible]  14.[illegible]    21.2
               MP   25= 32.0   50= 34.7   75= 40.0
OTHER          N    [illegible]
               V                   2.[illegible]        7.[illegible]                             .[illegible]
               MP   25= 27.0   50= 37.0   75= 47.0
NO RESPONSE    N    [illegible]
               V                   5.[illegible]  1.[illegible]  1.[illegible]  2.[illegible]                        2.0
               MP   25= 27.6   50= 32.0   75= 38.3
TOTAL          N    [illegible]
               V                   100.0  100.0  100.[illegible]  99.[illegible]  99.[illegible]  100.0  100.0  100.0  100.0     100.0  100.0
               MP   25= 30.9   50= 34.1   75= 40.0

DIMENSION-001  PHD                                                                                    A42
DIMENSION-002  EMP SPEC1 PANEL GROUP 2 -- A P E
DIMENSION-003  EMP1 TOTAL KNOWN
BASIC RES      N    [illegible]
               V         100.0  66.[illegible]  54.[illegible]  44.[illegible]  36.3  30.[illegible]  23.[illegible]  33.3  26.[illegible]  23.1  50.0  47.3
               MP   25= 30.1   50= 33.5   75= 39.2
APPLIED RES    N    [illegible]
               V                14.[illegible]  14.[illegible]  16.[illegible]  11.3  10.[illegible]  14.3  16.7  8.[illegible]  7.[illegible]    13.[illegible]
               MP   25= 31.0   50= 34.5   75= 41.0
DEVEL+DESIGN   N    [illegible]
               V                .[illegible]  2.[illegible]  1.[illegible]  1.4  2.[illegible]  1.[illegible]  4.[illegible]          1.[illegible]
               MP   25= 31.7   50= 38.5   75= 43.3
MANAG - R+D    N    [illegible]
               V                .[illegible]  3.[illegible]  6.0  15.3  13.6  21.[illegible]  12.3  8.[illegible]  15.4      7.[illegible]
               MP   25= 37.5   50= 43.0   75= 49.0
MANAG - OTHER  N    [illegible]
               V                .[illegible]  .6  .[illegible]  3.4  6.4  9.[illegible]  4.[illegible]  8.[illegible]  7.[illegible]      2.3
               MP   25= 41.8   50= 47.0   75= 52.1
TEACHING       N    [illegible]
               V                11.[illegible]  21.6  20.[illegible]  20.4  24.3  23.6  20.8  43.[illegible]  23.[illegible]  33.3  23.3
               MP   25= 32.4   50= 37.4   75= 44.1
OTHER          N    [illegible]
               V                1.[illegible]  .6  1.[illegible]  .[illegible]  1.[illegible]  1.[illegible]      4.[illegible]  15.4  16.[illegible]  1.3
               MP   25= 33.3   50= 44.5   75= 62.0
NO RESPONSE    N    [illegible]
               V                3.[illegible]  2.6  .[illegible]  2.[illegible]  1.[illegible]  3.[illegible]  8.[illegible]      7.[illegible]      2.3
               MP   25= 30.2   50= 34.5   75= 37.0
TOTAL          N    [illegible]
               V         100.0  100.0  100.0  100.0  100.1  99.[illegible]  99.[illegible]  100.0  100.0  100.1  100.0  100.0
               MP   25= 31.2   50= 35.5   75= 41.3
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DIMENSION=001 PHD
DIMENSION=002 EXP. SPEC1 PANEL GROUP 3 -- E P
DIMENSION=003 EMP. TOTAL KNOWN

A43

BASIC RES	N % MP	25= 29.8	50= 33.3	75= 38.6	[illegible]
APPLIED RES	N % MP	25= 31.9	50= 36.3	75= 42.1	[illegible]
DEVEL+DESIGN	N % MP	25= 32.8	50= 36.7	75= 40.7	[illegible]
MANAG - R+D	N % MP	25= 38.3	50= 43.1	75= 49.7	[illegible]
MANAG - OTHER	N % MP	25= 37.8	50= 46.2	75= 55.8	[illegible]
TEACHING	N % MP	25= 31.7	50= 35.3	75= 40.1	[illegible]
OTHER	N % MP	25= 29.8	50= 32.8	75= 38.3	[illegible]
NO RESPONSE	N % MP	25= 30.8	50= 35.4	75= 43.6	[illegible]
TOTAL	N % MP	25= 30.6	50= 34.3	75= 40.2	[illegible]

DIMENSION=001 PHD
DIMENSION=002 EXP. SPEC1 PANEL GROUP 4 -- R P
DIMENSION=003 EMP. TOTAL KNOWN

A44

BASIC RES	N % MP	25= 30.8	50= 35.2	75= 42.8	[illegible]
APPLIED RES	N % MP	25= 31.6	50= 37.0	75= 43.6	[illegible]
DEVEL+DESIGN	N % MP	25= 30.4	50= 33.1	75= 38.7	[illegible]
MANAG - R+D	N % MP	25= 40.7	50= 55.7	75= 59.8	[illegible]
MANAG - OTHER	N % MP	25= 37.6	50= 44.4	75= 57.8	[illegible]
TEACHING	N % MP	25= 32.0	50= 37.9	75= 44.6	[illegible]
OTHER	N % MP	25= 31.6	50= 37.8	75= 43.1	[illegible]
NO RESPONSE	N % MP	25= 35.1	50= 41.2	75= 48.8	[illegible]
TOTAL	N % MP	25= 32.1	50= 37.6	75= 44.8	[illegible]

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DIMENSION-001  EMP
DIMENSION-002  EMP SPEC1 PANEL GROUP 5A --
DIMENSION-003  EMP, TOTAL KNOWN
BASIC RES
                 N
                 V
APPLIED RES      NP   25= 30.9    50= 35.4  [illegible]  75= 43.3  22.[illegible]  19.[illegible]  20.[illegible]  21.[illegible]  11.[illegible]  40.[illegible]      20.[illegible]  33.[illegible]      A45
                 N
                 V
DEVEL+DESIGN     NP   25= 32.0    50= 36.3  [illegible]  75= 43.2  22.[illegible]  16.[illegible]  13.[illegible]  15.[illegible]  22.[illegible]  20.[illegible]  44.[illegible]  21.[illegible]
                 N
                 V
MANAG - R+D      NP   25= 31.5    50= 33.6  5.[illegible]  75= 41.4  2.[illegible]  2.[illegible]      2.[illegible]
                 N
                 V
MANAG - OTHER    NP   25= 38.5    50= 43.0  [illegible]  75= 48.8  20.[illegible]  24.[illegible]  20.[illegible]  21.[illegible]  22.[illegible]  20.[illegible]      13.[illegible]  33.[illegible]
                 N
                 V
TEACHING         NP   25= 39.5    50= 46.2  [illegible]  75= 49.5  1.[illegible]  3.[illegible]  2.[illegible]  5.[illegible]      1.[illegible]
                 N
                 V
OTHER            NP   25= 32.9    50= 38.5  [illegible]  75= 46.9  20.[illegible]  30.[illegible]  30.[illegible]  31.[illegible]  11.[illegible]      25.[illegible]  33.[illegible]
                 N
                 V
NO RESPONSE      NP   25= 36.4    50= 42.0    75= 60.0  1.[illegible]  2.[illegible]  11.[illegible]  33.[illegible]  1.[illegible]
                 N
                 V
TOTAL            NP   25= 39.1    50= 43.9  [illegible]  75= 50.8  4.[illegible]  3.[illegible]  2.[illegible]  5.[illegible]  22.[illegible]      2.[illegible]
                 N
                 V
                 NP   25= 32.5    50= 38.1  100.[illegible]  100.[illegible]  75= 45.6  100.[illegible]  100.[illegible]  100.[illegible]  100.[illegible]  99.[illegible]  100.[illegible]  100.[illegible]  99.[illegible]  99.[illegible]

DIMENSION-001  EMP
DIMENSION-002  EMP SPEC1 PANEL GROUP 5B -- P
DIMENSION-003  EMP, TOTAL KNOWN
BASIC RES
                 N
                 V
APPLIED RES      NP   25= 30.6  50.[illegible]  50= 34.1  [illegible]  75= 39.4  37.[illegible]  33.[illegible]  17.[illegible]  10.[illegible]      50.[illegible]      43.[illegible]      A46
                 N
                 V
DEVEL+DESIGN     NP   25= 31.3  50.[illegible]  50= 35.2  25.[illegible]  75= 41.8  20.[illegible]  22.[illegible]  35.[illegible]      20.[illegible]      21.[illegible]
                 N
                 V
MANAG - R+D      NP   25= 36.4    50= 38.3    75= 50.0      5.[illegible]      .[illegible]
                 N
                 V
MANAG - OTHER    NP   25= 37.3    50= 41.8  1.[illegible]  75= 47.4  16.[illegible]  18.[illegible]  23.[illegible]  40.[illegible]  40.[illegible]      10.[illegible]
                 N
                 V
TEACHING         NP   25= 37.0    50= 44.5  .[illegible]  75= 52.0  1.[illegible]  2.[illegible]      10.[illegible]      .[illegible]
                 N
                 V
OTHER            NP   25= 33.1    50= 37.3  20.[illegible]  75= 42.5  24.[illegible]  18.[illegible]  17.[illegible]  30.[illegible]  40.[illegible]  50.[illegible]      20.[illegible]
                 N
                 V
NO RESPONSE
                 N
                 V
TOTAL            NP   25= 28.9    50= 34.5  1.[illegible]  75= 38.9      4.[illegible]      10.[illegible]      2.[illegible]
                 N
                 V
                 NP   25= 31.0  100.[illegible]  50= 36.0  100.[illegible]  100.0  75= 41.5  100.[illegible]  100.[illegible]  99.[illegible]  100.[illegible]  100.[illegible]  100.[illegible]      99.[illegible]
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DIMENSION-001  PHD                                                                                     A47
DIMENSION-002  EMP SPEC: PANEL GROUP 5 -- P & F
DIMENSION-003  EMP: TOTAL KNOWN
BASIC RES        N                  1     69    124     79     57     31     12      5      1      4             382      1
                 V               50.0   59.5   39.2   32.9   30.3   24.4   19.7   17.2    7.1   57.1            34.7   33.3
                 MP   25= 30.6      50= 34.4      75= 40.8
APPLIED RES      N                  1     27     90     62     45     24     12      3      3      1      2      270
                 V               50.0   23.3   28.5   25.8   23.9   18.9   19.7   10.3   21.4   14.3   66.7    24.5
                 MP   25= 31.7      50= 35.9      75= 42.0
DEVEL+DESIGN     N                                8      3      2      2      1                                16
                 V                              2.5    1.3    1.1    1.6    1.6                               1.5
                 MP   25= 32.0      50= 34.5      75= 42.0
MANAG - R+D      N                               16     25     35     28     13      8      4      1            130      1
                 V                              5.1   10.4   18.6   22.0   21.3   27.6   28.6   14.3            11.8   33.3
                 MP   25= 37.0      50= 42.9      75= 48.3
MANAG - OTHER    N                                2      1      2      4      1      2                                12
                 V                               .6     .4    1.1    3.1    1.6    6.9                               1.1
                 MP   25= 39.5      50= 45.8      75= 49.5
TEACHING         N                         14     72     61     42     33     20      9      3      1            255      1
                 V                       12.1   22.8   25.4   22.3   26.0   32.8   31.0   21.4   14.3            23.2   33.3
                 MP   25= 33.0      50= 37.9      75= 44.8
OTHER            N                          1             2      1             1             1             1      7
                 V                         .9            .8     .5           1.6           7.1          33.3     .6
                 MP   25= 36.4      50= 42.0      75= 60.8
NO RESPONSE      N                          4      4      7      4      5      1      2      2                    29
                 V                        3.4    1.3    2.9    2.1    3.9    1.6    6.9   14.3                   2.6
                 MP   25= 33.6      50= 39.1      75= 47.1
TOTAL            N                  2    116    316    240    188    127     61     29     14      7      3     1101      3
                 V              100.0  100.0  100.0   99.9   99.9   99.9   99.9   99.9   99.9  100.0  100.0   100.0   99.9
                 MP   25= 32.0      50= 37.0      75= 43.6

DIMENSION-001  PHD                                                                                     A48
DIMENSION-002  EMP SPEC: PANEL GROUP 6 -- C M
DIMENSION-003  EMP: TOTAL KNOWN
BASIC RES        N                  1    295    548    350    195    104     39     16     15      6      3     1572      2
                 V              100.0   60.3   44.1   38.3   29.4   22.8   22.8   15.0   23.4   17.1   42.9    37.9   40.0
                 MP   25= 30.4      50= 34.0      75= 39.3
APPLIED RES      N                       119    303    194    125     82     20     23      9      7      1      883
                 V                       24.3   24.4   21.2   18.8   18.0   11.7   21.5   14.1   20.0   14.3    21.3
                 MP   25= 31.2      50= 35.0      75= 41.4
DEVEL+DESIGN     N                        11     34     26     15      4      4      1      1      1      1       98
                 V                        2.2    2.7    2.8    2.3     .9    2.3     .9    1.6    2.9   14.3     2.4
                 MP   25= 31.5      50= 35.3      75= 40.3
MANAG - R+D      N                         4     49     84    127    113     42     19     11      5             454      1
                 V                         .8    3.9    9.2   19.1   24.8   24.6   17.8   17.2   14.3            10.9   20.0
                 MP   25= 38.1      50= 43.0      75= 47.9
MANAG - OTHER    N                         3     13      5     30     36     13     10      3      3             116
                 V                         .6    1.0     .5    4.5    7.9    7.6    9.3    4.7    8.6             2.8
                 MP   25= 40.8      50= 45.5      75= 49.5
TEACHING         N                        46    262    232    152    105     42     25     17     10             891      2
                 V                        9.4   21.1   25.4   22.9   23.0   24.6   23.4   26.6   28.6            21.5   40.0
                 MP   25= 32.9      50= 37.5      75= 43.7
OTHER            N                         5     10      6      4      5      6      8      5      2      1       52
                 V                        1.0     .8     .7     .6    1.1    3.5    7.5    7.8    5.7   14.3     1.3
                 MP   25= 33.5      50= 45.5      75= 56.4
NO RESPONSE      N                         6     24     18     16      7      5      5      3      1      1       88
                 V                        1.2    1.9    2.0    2.4    1.5    2.9    4.7    4.7    2.9   14.3     2.1
                 MP   25= 32.7      50= 38.1      75= 44.9
TOTAL            N                  1    489   1243    915    664    456    171    107     64     35      7     4152      5
                 V              100.0   99.8   99.9  100.1  100.0  100.0  100.0  100.1  100.1  100.1  100.1   100.2  100.0
                 MP   25= 31.7      50= 36.4      75= 43.0
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DIMENSION-001  PHD
DIMENSION-002  EMP SPECS PANEL GROUP 7 -- S & P
DIMENSION-003  EMP: TOTAL KNOWN
BASIC RES       N
                V
                MP   25= 30.9   50= 34.6  61.1  75= 41.2  42.0  30.0  30.2  18.2  20.0        30.0  40.1
APPLIED RES     N
                V
                MP   25= 31.4   50= 36.7  20.2  75= 44.1  19.3  21.3  18.9  12.1        25.0        17.1
DEVEL+DESIGN    N
                V
                MP   25= 28.7   50= 32.8   1.6  75= 38.3         1.1         3.0                     1.4
MANAG - R+D     N
                V
                MP   25= 39.5   50= 44.6   2.1  75= 50.6  23.3  27.3  35.8  24.2  40.0  25.0        15.3
MANAG - OTHER   N
                V
                MP   25= 33.3   50= 43.8   1.6  75= 53.9    .8   2.5   3.8   9.1                     1.8
TEACHING        N
                V
                MP   25= 33.9   50= 39.1   7.8  75= 47.6  10.1  13.8   9.3  24.2  20.0  25.0        11.3
OTHER           N
                V
                MP   25= 29.5   50= 34.9   2.6  75= 32.8         3.8         3.0  20.0  25.0  50.0   2.8
NO RESPONSE     N
                V
                MP   25= 34.2   50= 40.0   2.1  75= 41.8   4.2         1.3   6.1                     2.1
TOTAL           N
                V
                MP   25= 31.9   100.1 50= 37.4  100.1  100.1  75= 44.8  99.9  100.2  100.0  99.9  100.0  100.0  100.0  100.0
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DIMENSION-001  PHD
DIMENSION-002  EMP SPECS PANEL GROUP 8 -- 810
DIMENSION-003  EMP: TOTAL KNOWN
BASIC RES       N
                V
                MP   25= 30.5   50= 35.5  61.8  75= 44.3  53.6  55.6  37.0  45.5  16.7  100.0  100.0  57.1
APPLIED RES     N
                V
                MP   25= 32.8   50= 37.5   8.8  75= 49.5         8.3  14.8        16.7                7.3
DEVEL+DESIGN    N
                V
                MP   25= 29.5   50= 34.5   1.5  75= 39.5   3.6                                        1.5
MANAG - R+D     N
                V
                MP   25= 39.0   50= 48.3   1.5  75= 53.3   7.1  11.1  22.2   9.1  50.0                8.0
MANAG - OTHER   N
                V
                MP   25= 44.5   50= 49.5        75= 52.0   3.6   2.8   7.4                            1.5
TEACHING        N
                V
                MP   25= 32.6   50= 38.4  22.1  75= 46.8  28.6  22.2  14.8  45.5  16.7               20.8
OTHER           N
                V
                MP   25= 30.8   50= 37.0   1.5  75= 43.3   3.6         3.7                            1.8
NO RESPONSE     N
                V
                MP   25= 32.0   50= 34.5   2.9  75= 37.0                                              1.5
TOTAL           N
                V
                MP   25= 31.7   100.1 50= 37.2  100.1  100.0  75= 46.5  100.1  100.0  99.9  100.1  100.1  100.0  100.0  100.1
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DIMENSION-001  PHD                                                                                            A51
DIMENSION-002  EMP  SPEC1 PANEL GROUP 9 -- OPTICS
DIMENSION-003  EMP, TOTAL KNOWN
BASIC RES       N                   30      79      41      26      15                                           201
                V            34.9   28.9    19.6    16.4    10.4    7.3    3.6    7.1    6.1                      18.6
                MP  25= 30.8   50= 34.1         75= 39.8
APPLIED RES     N                   32     117      76      50      39                                           342
                V            37.2   42.9    35.2    31.4    27.1   17.3   33.9   25.6   10.0   25.0              33.6
                MP  25= 32.0   50= 38.6         75= 44.2
DEVEL+DESIGN    N                    4      17      15       8                                                    54
                V             4.7    6.2     6.9     5.0     2.1    3.6    5.4    7.1                             5.2
                MP  25= 32.4   50= 38.8         75= 43.3
MANAG - R+D     N                    5      22      44      42      45                                           211
                V             5.8    8.1    20.4    26.6    31.3   31.3   26.8   25.6   12.5   12.5              20.6
                MP  25= 37.4   50= 43.6         75= 49.6
MANAG - OTHER   N                    2       1       9                                                            34
                V             2.3     .4     4.2     3.1     3.5    3.6    8.9    7.1   12.5                      3.3
                MP  25= 37.3   50= 44.5         75= 53.3
TEACHING        N                    7      31      21      20      29                                           159
                V             8.1   11.4     9.7    12.6    16.1   37.5   16.1   15.4   37.5   25.0              15.9  100.0
                MP  25= 34.4   50= 43.9         75= 51.2
OTHER           N                    2       4       3                                                            33
                V             2.3    1.5     1.4     3.1     3.5    5.0    3.6   10.3   12.5   25.0               3.1
                MP  25= 38.3   50= 47.0         75= 58.9
NO RESPONSE     N                    4       1       5                                                            24
                V             4.7     .4     2.3     1.9     4.2    3.6    1.8                  12.5               2.2
                MP  25= 35.5   50= 42.8         75= 48.7
TOTAL           N                   86     273     216     159     144                                          1077
                V           100.0  100.1   100.0    99.9   100.2  100.2  100.1  100.0  100.1  100.0              99.9  100.0
                MP  25= 32.9   50= 38.7         75= 47.1

DIMENSION-001  PHD                                                                                            A52
DIMENSION-002  EMP  SPEC1 PANEL GROUP 10 -- ACOUSTICS
DIMENSION-003  EMP, TOTAL KNOWN
BASIC RES       N                    9      11       4                                                            39
                V            34.6   15.3     6.9    12.2     7.3    3.1   12.6    7.1    8.3   20.0              12.0
                MP  25= 29.8   50= 34.1         75= 53.9
APPLIED RES     N                   10      34      25      10       9      10                                   106
                V            38.5   47.2    43.1    20.4    22.0   37.0   20.0   21.4    8.3                      32.7
                MP  25= 31.9   50= 36.3         75= 44.8
DEVEL+DESIGN    N                    3       3       3                                                            16
                V            11.5    4.2     5.2     8.2     2.4                               16.7                4.9
                MP  25= 31.2   50= 37.8         75= 43.1
MANAG - R+D     N                            4      10      16      17      10                                    68
                V                    5.6    17.2    32.7    41.5   37.0   20.0   21.4   33.3                      21.0
                MP  25= 40.6   50= 45.7         75= 51.5
MANAG - OTHER   N                            1       1                                                             7
                V                    1.4     1.7     2.0                   7.1   10.0           8.3                2.2
                MP  25= 38.3   50= 52.0         75= 57.6
TEACHING        N                    4      12      12      10       8                                            59
                V            15.4   16.7    20.7    20.4    19.5   11.1   20.0   35.7          20.0              18.2
                MP  25= 34.0   50= 40.3         75= 48.4
OTHER           N                            4       3                                                            18
                V                    5.6     5.2     2.0     4.9           10.0   14.3   25.0   20.0               5.6
                MP  25= 35.3   50= 47.0         75= 63.3
NO RESPONSE     N                            3                                                                    11
                V                    4.2             2.0     2.4    7.4   10.0                  40.0               3.4
                MP  25= 34.1   50= 50.8         75= 57.6
TOTAL           N                   26      72      58      49      41      27      20      14      12       5   324
                V           100.0  100.2   100.0    99.9   100.0   99.9  100.0   99.9   99.9  100.0             100.0
                MP  25= 33.3   50= 40.6         75= 49.1
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DIMENSION-001  PHD
DIMENSION-002  EMP   SPEC1 PANEL GROUPS 11-15 -- ASTRONOMY
DIMENSION-003  EMP1  TOTAL KNOWN
BASIC RES      N   [illegible]
               V   [illegible]  61.0  [illegible]  55.0  47.[illegible]  53.[illegible]  35.0  29.2  66.[illegible]  50.0  56.[illegible]  100.0
               MP  25= 30.3   50= 34.1   75= 41.3
APPLIED RES    N   [illegible]
               V   [illegible]  9.5  [illegible]  7.[illegible]  6.[illegible]  10.0  16.[illegible]  7.[illegible]
               MP  25= 29.2   50= 32.5   75= 39.3
DEVEL+DESIGN   N   [illegible]
               V   [illegible]  1.0  [illegible]  1.[illegible]  5.0  1.[illegible]
               MP  25= 27.0   50= 32.0   75= 39.5
MANAG - R+D    N   [illegible]
               V   3.[illegible]  10.[illegible]  16.[illegible]  29.[illegible]  23.[illegible]  30.0  45.0  8.[illegible]  16.[illegible]  11.[illegible]
               MP  25= 39.4   50= 46.1   75= 55.5
MANAG - OTHER  N   [illegible]
               V   .[illegible]  [illegible]  3.0  4.[illegible]  3.[illegible]  1.[illegible]
               MP  25= 37.0   50= 41.2   75= 45.0
TEACHING       N   [illegible]
               V   14.[illegible]  20.[illegible]  15.[illegible]  16.[illegible]  10.[illegible]  16.[illegible]  15.0  25.0  25.0  15.1
               MP  25= 31.0   50= 34.3   75= 42.0
OTHER          N   [illegible]
               V   [illegible]  3.0  [illegible]  2.1  1.[illegible]
               MP  25= 30.0   50= 32.0   75= 35.0
NO RESPONSE    N   [illegible]
               V   [illegible]  1.0  3.[illegible]  5.0  16.[illegible]  1.[illegible]
               MP  25= 28.9   50= 33.1   75= 55.0
TOTAL          N   106  200  107  80  [illegible]
               V   100.[illegible]  100.0  100.[illegible]  100.2  100.1  99.[illegible]  100.0  100.0  100.0  100.1  100.1  100.0
               MP  25= 30.8   50= 35.0   75= 43.4
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A54

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DIMENSION-001  PHD
DIMENSION-002  EMP   SPEC1 PANEL GROUP 16 -- MISC
DIMENSION-003  EMP1  TOTAL KNOWN
BASIC RES      N   [illegible]  50  41  [illegible]
               V   20.[illegible]  7.0  7.0  5.0  4.[illegible]  3.[illegible]  2.[illegible]  4.[illegible]  3.[illegible]  3.0  [illegible]
               MP  25= 30.4   50= 36.1   75= 44.0
APPLIED RES    N   35  [illegible]  77  70  [illegible]
               V   15.[illegible]  17.6  13.[illegible]  13.4  10.5  12.0  5.2  4.[illegible]  4.[illegible]  12.6  20.0
               MP  25= 32.4   50= 38.2   75= 51.1
DEVEL+DESIGN   N   [illegible]
               V   3.[illegible]  3.4  2.[illegible]  1.[illegible]  2.0  1.[illegible]  2.[illegible]  1.[illegible]  1.0  2.[illegible]
               MP  25= 32.0   50= 37.0   75= 40.0
MANAG - R+D    N   [illegible]  43  69  99  [illegible]
               V   3.[illegible]  6.0  11.[illegible]  10.9  21.[illegible]  27.5  20.2  17.4  9.5  3.0  14.0  20.0
               MP  25= 39.9   50= 46.0   75= 52.2
MANAG - OTHER  N   [illegible]
               V   2.[illegible]  3.0  7.[illegible]  13.0  16.5  19.0  17.5  11.0  10.5  9.[illegible]  10.4
               MP  25= 40.5   50= 46.3   75= 53.1
TEACHING       N   103  [illegible]
               V   46.[illegible]  36.1  46.[illegible]  41.5  38.6  34.0  46.4  46.0  57.1  60.6  48.1  60.0
               MP  25= 33.3   50= 39.8   75= 49.0
OTHER          N   17  43  40  [illegible]
               V   7.[illegible]  6.0  6.[illegible]  3.0  3.4  4.5  4.0  5.0  6.5  21.[illegible]  5.5
               MP  25= 33.0   50= 38.9   75= 51.2
NO RESPONSE    N   [illegible]
               V   [illegible]  2.[illegible]  1.[illegible]  2.[illegible]  2.[illegible]  .[illegible]  .[illegible]  1.[illegible]  3.[illegible]  3.0  2.0
               MP  25= 35.0   50= 43.0   75= 47.0
TOTAL          N   224  715  509  323  [illegible]
               V   99.[illegible]  100.0  100.[illegible]  100.0  99.[illegible]  100.0  99.[illegible]  99.[illegible]  100.0  99.[illegible]  100.0  100.0
               MP  25= 34.0   50= 41.5   75= 47.4
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PTB AGE BY PRIMARY ACTIVITY BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: COLLEGE OR UNIVERSITY

A55

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL NO	NO RESP.
BASIC RES	N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 29.9		50= 33.5		75= 39.3									
APPLIED RES	N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 31.9		50= 36.6		75= 41.0									
DEVEL+DESIGN	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	
	MP	25= 29.8		50= 33.9		75= 41.4									
MANAG - R+D	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	MP	25= 40.2		50= 45.7		75= 51.3									
MANAG - OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 40.9		50= 46.6		75= 52.8									
TEACHING	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 32.9		50= 38.2		75= 44.1									
OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 30.5		50= 35.8		75= 48.3									
NO RESPONSE	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 32.4		50= 38.9		75= 46.6									
TOTAL	N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 31.1		50= 36.1		75= 44.4									

DIMENSION-001 PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: PRIVATE INDUSTRY

A56

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL NO	NO RESP.
BASIC RES	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 30.6		50= 34.1		75= 39.4									
APPLIED RES	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 31.3		50= 35.2		75= 42.0									
DEVEL+DESIGN	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 31.6		50= 35.5		75= 41.6									
MANAG - R+D	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 38.2		50= 43.6		75= 49.0									
MANAG - OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 33.6		50= 43.3		75= 49.8									
TEACHING	N				[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	
	%				[illegible]	[illegible]	[illegible]	[illegible]						[illegible]	
	MP	25= 32.0		50= 34.5		75= 50.9									
OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 32.6		50= 38.5		75= 45.2									
NO RESPONSE	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 33.6		50= 40.8		75= 46.9									
TOTAL	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 32.3		50= 37.2		75= 44.9									

STD AGE BY PRIMARY ACTIVITY BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: GOVERNMENT-FEDERAL ETC.

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		AGE													
PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 31.5		50= 36.0		75= 42.0									
APPLIED RES	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 32.0		50= 37.3		75= 44.6									
DEVEL+DESIGN	N			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]		[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]		[illegible]	
	MP	25= 31.1		50= 37.0		75= 44.1									
MANAG - R+D	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 40.2		50= 45.7		75= 51.9									
MANAG - OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 36.6		50= 46.8		75= 56.0									
TEACHING	N			[illegible]	[illegible]							[illegible]		[illegible]	
	%			[illegible]	[illegible]							[illegible]		[illegible]	
	MP	25= 29.5		50= 32.0		75= 44.5									
OTHER	N				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 36.7		50= 45.8		75= 61.4									
NO RESPONSE	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 35.2		50= 42.5		75= 52.5									
TOTAL	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 32.9		50= 38.1		75= 46.7									

DIMENSION-001 PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: RESEARCH CENTER

A58

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 31.7		50= 35.6		75= 42.1									
APPLIED RES	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 32.2		50= 36.9		75= 43.4									
DEVEL+DESIGN	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 31.6		50= 35.8		75= 44.0									
MANAG - R+D	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 39.0		50= 44.7		75= 49.7									
MANAG - OTHER	N			[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	%			[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 41.8		50= 46.5		75= 51.7									
TEACHING	N														
	%														
OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
	MP	25= 31.0		50= 36.0		75= 42.2									
NO RESPONSE	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 32.2		50= 37.8		75= 46.6									
TOTAL	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	%			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 32.4		50= 37.4		75= 44.0									

018 AGE BY PRIMARY ACTIVITY BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: OTHER KNOWN

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N			71	74	42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	
	V			[illegible]	40.2	[illegible]	10.8	20.6	19.2	[illegible]	[illegible]		[illegible]	[illegible]	
	MP	25= 29.0		50= 33.3		75= 38.6									
APPLIED RES	N			19	42	27	20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V			[illegible]	24.5	[illegible]	20.8	15.3	20.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 31.8		50= 37.5		75= 47.5									
DEVEL+DESIGN	N			3	7	1	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	V			[illegible]	3.6	[illegible]	1.0	4.1	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 31.3		50= 34.5		75= 52.0									
MANAG - R+D	N			4	9	18	26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V			[illegible]	4.6	[illegible]	27.1	17.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 36.0		50= 43.3		75= 50.5									
MANAG - OTHER	N			4	9	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	V			[illegible]	4.6	[illegible]	19.6	22.4	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 36.9		50= 43.7		75= 52.7									
TEACHING	N			[illegible]	21	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 35.0		50= 41.8		75= 51.8									
OTHER	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 34.6		50= 47.0		75= 60.5									
NO RESPONSE	N			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	17	
	V			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	
	MP	25= 35.3		50= 43.3		75= 48.7									
TOTAL	N			173	184	138	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V			100.0	100.0	[illegible]	100.0	100.0	100.0	100.0	100.0	[illegible]	100.0	[illegible]	
	MP	25= 31.9		50= 38.6		75= 45.1									

DIMENSION-001 PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: TOTAL KNOWN

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N		4	1043	1901	1122	713	425	179	83	56	33	18	5599	8
	V		80.0	[illegible]	42.6	[illegible]	26.7	21.6	18.5	13.2	13.2	14.3	23.1	34.9	42.1
	MP	25= 30.5		50= 35.1		75= 40.3									
APPLIED RES	N		1	314	874	543	403	278	129	82	52	23	[illegible]	2728	1
	V		20.0	[illegible]	19.6	[illegible]	16.2	14.1	13.4	13.0	12.0	10.0	7.9	16.8	5.3
	MP	25= 31.8		50= 36.0		75= 43.1									
DEVEL+DESIGN	N			43	125	79	49	21	17	13	6	4	1	378	
	V			[illegible]	2.8	[illegible]	2.0	1.1	1.8	2.1	1.3	1.7	1.3	2.3	
	MP	25= 31.5		50= 35.6		75= 42.6									
MANAG - R+D	N			22	184	314	457	456	253	130	91	29	3	1927	3
	V			[illegible]	4.1	[illegible]	18.3	23.2	26.2	20.6	22.3	12.6	3.8	11.9	15.8
	MP	25= 38.9		50= 44.4		75= 49.9									
MANAG - OTHER	N			15	62	77	134	167	88	72	32	21	3	671	
	V			[illegible]	1.4	[illegible]	5.3	8.6	9.1	11.4	7.8	9.1	3.8	4.1	
	MP	25= 40.0		50= 45.9		75= 52.2									
TEACHING	N			273	1153	899	637	510	251	202	138	91	26	4180	7
	V			[illegible]	25.8	[illegible]	25.5	26.1	26.0	32.0	33.8	39.4	33.3	25.8	36.8
	MP	25= 32.8		50= 38.2		75= 46.2									
OTHER	N			43	88	61	33	42	27	26	27	23	13	384	
	V			[illegible]	2.0	[illegible]	1.3	2.3	2.8	4.1	6.6	10.0	16.2	2.3	
	MP	25= 32.7		50= 37.4		75= 52.9									
NC RESPONSE	N			35	79	65	58	44	22	22	11	7	7	353	
	V			[illegible]	1.8	[illegible]	2.3	2.4	2.3	3.4	2.9	3.0	7.9	2.2	
	MP	25= 32.9		50= 38.3		75= 47.4									
TOTAL	N		5	1600	4467	3199	2494	1973	966	631	408	231	78	16229	19
	V		100.0	100.0	100.1	100.0	100.0	100.1	100.1	100.0	99.4	100.1	99.9	100.1	100.0
	MP	25= 32.0		50= 37.6		75= 45.C									

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019 AGE BY PRIMARY ACTIVITY BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 NO PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: COLLEGE OR UNIVERSITY

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N		256	1793	619	111	29	17	[illegible]	[illegible]	[illegible]			2620	9
	%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
	MP	25= 25.6		50= 27.5		75= 30.3									
APPLIED RES	N		30	141	79	24	22	16	[illegible]	[illegible]		[illegible]		240	
	%		[illegible]	[illegible]	8.0	[illegible]	10.8	8.9	[illegible]	[illegible]		[illegible]		[illegible]	
	MP	25= 26.1		50= 29.8		75= 33.7									
DEVEL+DESIGN	N		4	31	17	3	4	2	[illegible]		[illegible]	[illegible]		44	
	%		.8	[illegible]	1.7	[illegible]	2.0	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	
	MP	25= 26.6		50= 29.0		75= 33.3									
MANAG - R+D	N			3	10	12	8	10	[illegible]	[illegible]	[illegible]			98	
	%			[illegible]	1.0	[illegible]	3.9	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 34.1		50= 40.8		75= 48.0									
MANAG - OTHER	N		1	5	20	20	17	9	[illegible]	10	[illegible]	[illegible]	1	96	
	%		.2	.2	2.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 34.0		50= 40.1		75= 49.5									
TEACHING	N		194	551	294	200	127	120	[illegible]	[illegible]	[illegible]	[illegible]	3	1864	3
	%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	75.0	[illegible]	23.1
	MP	25= 27.0		50= 31.8		75= 41.7									
OTHER	N		24	39	24	9	3	2			[illegible]	[illegible]		128	
	%		[illegible]	[illegible]	2.4	[illegible]	1.5	1.1			[illegible]	[illegible]		[illegible]	
	MP	25= 25.2		50= 27.4		75= 31.2									
NO RESPONSE	N		18	55	24	9	3	4	[illegible]	[illegible]	[illegible]	[illegible]		110	[illegible]
	%		[illegible]	[illegible]	2.4	[illegible]	1.5	2.2	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	MP	25= 26.1		50= 28.6		75= 31.1									
TOTAL	N		323	2060	987	390	203	180	103	103	61	32	4	4246	13
	%		100.1	100.1	99.9	100.1	100.1	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0
	MP	25= 26.0		50= 28.3		75= 33.3									

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DIMENSION-001 NO PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: PRIVATE INDUSTRY

PRIM ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N		1	48	38	31	21	19	12	[illegible]	[illegible]	1		192	
	%		1.4	4.3	2.8	4.0	3.1	3.3	3.7	3.8	7.4	10.0		3.6	
	MP	25= 29.6		50= 35.6		75= 43.8									
APPLIED RES	N		23	466	476	292	219	155	89	42	11	2	1	1782	1
	%		32.9	42.1	35.3	31.5	30.5	26.3	27.4	26.4	10.9	20.0	50.0	33.4	25.0
	MP	25= 29.0		50= 33.7		75= 41.3									
DEVEL+DESIGN	N		18	323	346	194	124	87	61	24	15	1		1195	1
	%		25.7	29.2	25.6	20.9	17.3	14.9	18.8	15.1	16.7	10.0		22.4	25.0
	MP	25= 28.9		50= 33.3		75= 40.0									
MANAG - R+D	N			30	153	181	202	158	84	42	23	1		876	2
	%			2.7	11.3	19.5	28.2	27.1	25.8	26.4	24.4	10.0		16.4	50.0
	MP	25= 35.5		50= 41.3		75= 47.2									
MANAG - OTHER	N		2	46	117	115	87	88	39	21	13		1	533	
	%		2.9	4.2	8.7	12.4	12.1	15.1	12.0	13.2	16.4		50.0	10.0	
	MP	25= 33.1		50= 38.9		75= 40.4									
TEACHING	N			3	3	6	1	2		1	2			19	
	%			.3	.2	.6	.1	.3		.6	2.2			.4	
	MP	25= 32.4		50= 37.6		75= 40.0									
OTHER	N		23	184	202	88	50	59	37	18	7	4		674	
	%		32.9	16.6	15.0	9.5	7.0	10.1	11.4	11.3	7.4	40.0		12.6	
	MP	25= 28.6		50= 32.7		75= 40.2									
NO RESPONSE	N		1	11	15	7	12	15	3	5	3	1		73	
	%		1.4	1.0	1.1	.8	1.7	2.6	.9	3.1	3.3	10.0		1.4	
	MP	25= 31.6		50= 40.5		75= 47.4									
TOTAL	N		70	1108	1350	927	717	594	329	159	95	10	2	5342	4
	%		100.0	100.1	100.1	100.0	100.0	100.1	100.0	99.9	100.0	100.0	100.0	100.2	100.0
	MP	25= 30.1		50= 35.3		75= 43.1									

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OTB AGE BY PRIMARY ACTIVITY BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE                         A63
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: GOVERNMENT-FEDERAL ETC.
                                                  AGE
                    UNDER                                                                OVER TOTAL  NO
PRIM ACTIV            20  20-24 25-29 30-34 35-39 40-44 45-49 50-54 55-59 60-64 65-69    70  RNGED  RESP.
BASIC RES        N            9   102   111    78    62    36    24     3     4     3          414     1
                 V         11.4  20.0  18.6  10.7  13.0  14.2  11.4   2.9  10.8  25.0         16.9  25.0
                 MP  25= 29.2    50= 33.9    75= 40.9
APPLIED RES      N           20   230   247   170   118    90    51    27     8     3          964     1
                 V         43.5  44.8  41.6  40.8  31.7  30.4  20.3  26.5  21.6  25.0         37.9  25.0
                 MP  25= 29.3    50= 34.2    75= 41.0
DEVEL+DESIGN     N            9    48    43    28    21    21    13     1     1     1          213     1
                 V         20.5   9.4  10.7   6.7   6.1   7.1   6.2    .9   2.1   8.3          8.5  25.0
                 MP  25= 29.1    50= 33.4    75= 42.1
MANAG - R+D      N            2    29    68    79    73    96    87    40    14     1          489
                 V          4.5   5.7  11.4  18.9  23.3  32.4  41.4  39.2  37.8   8.3         19.2
                 MP  25= 36.0    50= 44.1    75= 50.0
MANAG - OTHER    N                 21    27    19    19    21    13    13     4     2     1    142
                 V                4.1   4.5   4.6   6.1   7.1   6.2  12.7  10.8  16.7 100.0    5.6
                 MP  25= 32.2    50= 40.6    75= 49.4
TEACHING         N                  5     3     1                 1     1                       12
                 V                1.0    .5    .2                .5   1.0                       .5
                 MP  25= 28.3    50= 32.0    75= 36.6
OTHER            N            7    66    64    35    29    27    16     3     2     1          257     1
                 V         15.9  13.1  10.7   8.4   9.3   9.1   7.6   2.9   5.4   8.3         10.1  25.0
                 MP  25= 28.7    50= 33.7    75= 42.7
NO RESPONSE      N            1     7    10     8     4     3     5     1     4     1           46
                 V          2.3   1.4   1.7   1.9   1.2   1.0   2.4   1.0  10.8   8.3          1.8
                 MP  25= 31.3    50= 38.7    75= 49.0
TOTAL            N           44   513   596   417   313   296   210   102    37    12     1   2541     4
                 V        100.1 100.0  99.8 100.0 100.0 100.0 100.0 100.0  99.9  99.9 100.0  100.0 100.0
                 MP  25= 30.2    50= 35.9    75= 44.4

DIMENSION-001  NO PHD                                                                          A64
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP: RESEARCH CENTER
BASIC RES        N            6    97    51    29    14    28    12     3     2                234
                 V         54.5  51.1  27.4  19.3  11.6  18.3  21.8  15.0  14.3               26.9
                 MP  25= 27.2    50= 31.0    75= 38.3
APPLIED RES      N            2    36    65    54    49    35    14    10     3                269
                 V         18.2  18.9  34.9  35.7  40.5  26.3  25.5  50.0  21.4               30.7
                 MP  25= 31.0    50= 37.3    75= 43.9
DEVEL+DESIGN     N            2    30    29    22    10     9     4     1     2                110
                 V         18.2  15.8  15.6  14.6   8.3   7.3   7.3   5.0  14.3               12.6
                 MP  25= 28.8    50= 33.3    75= 35.2
MANAG - R+D      N                  3     8    20    31    39    11     3     3                114     1
                 V                1.6   4.3  12.7  25.6  29.3  20.0  15.0  21.4               13.0 100.0
                 MP  25= 38.9    50= 43.7    75= 47.9
MANAG - OTHER    N                  3    10    10     5     8     7     1     2                 44
                 V                1.6   5.4   6.4   4.1   5.0  12.7   5.0  14.3                5.0
                 MP  25= 33.5    50= 39.0    75= 48.7
TEACHING         N                  1     1           1                             1            3
                 V                 .5    .5          .8                          50.0           .3
                 MP  25= 29.5    50= 39.5    75= 57.8
OTHER            N            1    16    20    17    10    13     4     1     2     1           85
                 V          9.1   8.4  10.8  10.8   8.3  10.0   7.3   5.0  14.3  50.0          9.7
                 MP  25= 30.6    50= 36.1    75= 44.4
NO RESPONSE      N                  4     2     2     2           3     1                       14
                 V                2.1   1.1   1.3   1.7         5.5   5.0                      1.6
                 MP  25= 28.9    50= 37.0    75= 40.1
TOTAL            N           11   190   186   157   121   130    55    20    14     2          876     1
                 V        100.0 100.0 100.0 100.0 100.1  99.9 100.1 100.0 100.0 100.0        100.0 100.0
                 MP  25= 30.0    50= 36.1    75= 44.2
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OTR AGE BY PRIMARY ACTIVITY BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 NO PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: OTHER KNOWN

MAIN ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	[illegible]	
	MP	25= 26.1		50= 30.0		75= 34.1									
APPLIED RES	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
	MP	25= 27.0		50= 31.9		75= 37.0									
DEVEL+DESIGN	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 27.6		50= 33.7		75= 38.9									
MANAG - R+D	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 31.2		50= 37.9		75= 44.4									
MANAG - OTHER	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 29.6		50= 36.7		75= 44.7									
TEACHING	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 28.9		50= 35.0		75= 45.1									
OTHER	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 27.0		50= 32.0		75= 45.0									
NO RESPONSE	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
	MP	25= 25.4		50= 28.3		75= 33.3									
TOTAL	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 26.4		50= 34.2		75= 44.0									

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DIMENSION-001 NO PHD
DIMENSION-002 EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003 EMP: TOTAL KNOWN

MAIN ACTIV		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER 69	TOTAL KNOWN	NO RESP.
BASIC RES	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 28.0		50= 28.1		75= 32.0									
APPLIED RES	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 28.2		50= 33.9		75= 41.0									
DEVEL+DESIGN	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	MP	25= 28.7		50= 33.1		75= 39.9									
MANAG - R+D	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 35.3		50= 41.7		75= 48.2									
MANAG - OTHER	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	MP	25= 32.2		50= 38.1		75= 46.6									
TEACHING	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 28.0		50= 33.9		75= 41.9									
OTHER	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 27.0		50= 32.6		75= 41.2									
NO RESPONSE	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	MP	25= 26.0		50= 33.0		75= 40.0									
TOTAL	N		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	V		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MP	25= 27.0		50= 32.9		75= 41.1									

T- EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEG/EL 1970
CURRENT STATUS = STUDENT
[illegible]
[illegible]

EMPLOYMENT STATUS

FIELD OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER NO.AN.	TOTAL
ACO	N		1	1				2
	%		50.0	50.0				100.0
APC	N		3	1				4
	%		75.0	25.0				100.0
SP	N	3	6	5			2	16
	%	18.8	37.5	31.3			12.5	100.1
[illegible]	N	2	7	2	1		1	13
	%	15.4	53.8	15.4	7.7		7.7	100.0
F	N			1				1
	%			100.0				100.0
L C	N	1	3	1				5
	%	20.0	60.0	20.0				100.0
CVE	N	1	3	2				6
	%	16.7	50.0	33.3				100.0
CP	N	4	22	9	3		1	39
	%	10.3	56.4	23.1	7.7		2.6	100.1
SAP	N		3					3
	%		100.0					100.0
PIU	N	2						2
	%	100.0						100.0
CPE	N	1	1	2				4
	%	25.0	25.0	50.0				100.0
16 AC/CHS	N	1						1
	%	100.0						100.0
11-15 ASTRON	N	1	4	1				6
	%	16.7	66.7	16.7				100.1
16 MISC	N	4	10	2	4		1	21
	%	19.0	47.6	9.5	19.0		4.8	99.9
TOTAL	N	19	63	26	8		5	121
	%	15.7	52.1	21.5	6.6		4.1	100.0

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*T4 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - STUDENT
PHD OR NOT - PHD
SEX - FEMALE

		EMPLOYMENT STATUS						
SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER NO.R.	TOTAL
1 A+M	N		1					1
	%		100.0					100.0
2 AME	N							
	%							
3 EP	N			1				1
	%			100.0				100.0
4 NP	N			1				1
	%			100.0				100.0
3a P	N							
	%							
3b P	N							
	%							
5 P&F	N							
	%							
6 CM	N		1					1
	%		100.0					100.0
7 SUR	N							
	%							
8 BIO	N							
	%							
9 OPT	N							
	%							
10 ACOUS	N							
	%							
11-13 ASTRON	N							
	%							
14 MISC	N		1					1
	%		100.0					100.0
TOTAL	N		3	2				5
	%		60.0	40.0				100.0

HTS EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS = STUDENT
PHD OR NOT = PHD
SEX = TOTAL MALE + FEMALE

SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	NOT	OTHER UN.K.	TOTAL
		EMPLOYMENT STATUS						
1 AGR	N		2	1				3
	%		66.7	33.3				100.0
2 AMS	N		6	2				8
	%		75.0	25.0				100.0
3 EP	N	3	6	6			2	17
	%	17.6	35.3	35.3			11.8	100.0
4 MP	N	2	7	3	1		1	14
	%	14.3	50.0	21.4	7.1		7.1	99.9
5A P	N			1				1
	%			100.0				100.0
5B P	N	1	3	1				5
	%	20.0	60.0	20.0				100.0
5 P&P	N	1	3	2				6
	%	16.7	50.0	33.3				100.0
6 CP	N	4	23	9	3		1	40
	%	10.0	57.5	22.5	7.5		2.5	100.0
7 S&P	N		3					3
	%		100.0					100.0
8 BIO	N	2						2
	%	100.0						100.0
9 OPS	N	1	1	2				4
	%	25.0	25.0	50.0				100.0
10 ACCUS	N	1						1
	%	100.0						100.0
11-13 ASTRON	N	1	4	1				6
	%	16.7	66.7	16.7				100.1
14 MISC	N	4	11	2	4		1	22
	%	18.2	50.0	9.1	18.2		4.5	100.0
TOTAL	N	19	66	28	8		5	126
	%	15.1	52.4	22.2	6.3		4.0	100.0

*19 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - STUDENT
PHD OR NOT - NO PHD
SEX - MALE + UNKNOWN

SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER +N.R.	TOTAL
1 AMO	N	6	49	4	13		4	76
	%	7.9	64.5	5.3	17.1		5.3	100.1
2 APE	N	29	199	10	27		6	271
	%	10.7	73.4	3.7	10.0		2.2	100.0
3 EP	N	13	333	13	54		9	422
	%	3.1	78.9	3.1	12.8		2.1	100.0
4 NP	N	51	290	19	53		19	432
	%	11.8	67.1	4.4	12.3		4.4	100.0
5A P	N	20	47	2	5		2	76
	%	26.3	61.8	2.6	6.6		2.6	99.9
5B F	N	10	84	3	12		5	114
	%	8.8	73.7	2.6	10.5		4.4	100.0
5 P+F	N	30	131	5	17		7	190
	%	15.8	68.9	2.6	8.9		3.7	99.9
6 CM	N	131	641	45	114		39	970
	%	13.5	66.1	4.6	11.8		4.0	100.0
7 S+P	N	35	95	6	12		4	152
	%	23.0	62.5	3.9	7.9		2.6	99.9
8 BIO	N	4	31	3	9		3	50
	%	8.0	62.0	6.0	18.0		6.0	100.0
9 OPT	N	87	96	14	26		7	230
	%	37.8	41.7	6.1	11.3		3.0	99.9
10 ACOUS	N	30	28	2	4		1	65
	%	46.2	43.1	3.1	6.2		1.5	100.1
11-15 ASTRON	N	20	90	3	16		3	132
	%	15.2	68.2	2.3	12.1		2.3	100.1
16 MISC	N	283	312	28	127		42	792
	%	35.7	39.4	3.5	16.0		5.3	99.9
TOTAL	N	719	2295	152	472		144	3782
	%	19.0	60.7	4.0	12.5		3.8	100.0

019 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - STUDENT
PHD OR NOT - NO PHD
SEX - FEMALE

SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER N.R.	TOTAL
1 A+R	N		2		2			4
	%		50.0		50.0			100.0
2 AME	N		13		1		1	15
	%		86.7		6.7		6.7	100.1
3 EP	N		7	1	6		1	15
	%		46.7	6.7	40.0		6.7	100.1
4 MP	N	1	9		1			11
	%	9.1	81.8		9.1			100.0
5A F	N		1					1
	%		100.0					100.0
5B P	N		3		1			4
	%		75.0		25.0			100.0
5 P&F	N		4		1			5
	%		80.0		20.0			100.0
6 CH	N	3	21	4	6		1	35
	%	8.6	60.0	11.4	17.1		2.9	100.0
7 S&P	N		5					5
	%		100.0					100.0
8 BIO	N		2		1			3
	%		66.7		33.3			100.0
9 OPT	N		2	1				3
	%		66.7	33.3				100.0
10 ACCUS	N	1	1					2
	%	50.0	50.0					100.0
11-15 ASTRON	N	1	9	1	2			13
	%	7.7	69.2	7.7	15.4			100.0
16 MISC	N	14	26	5	15		5	65
	%	21.5	40.0	7.7	23.1		7.7	100.0
TOTAL	N	20	101	12	35		8	176
	%	11.4	57.4	6.8	19.9		4.5	100.0

*70 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - STUDENT
PHD OR NOT - NO PHD
SEX - TOTAL MALE + FEMALE

		EMPLOYMENT STATUS						
SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER +N.R.	TOTAL
1 A+M	N	6	51	4	15		4	80
	%	7.5	63.8	5.0	18.8		5.0	100.1
2 APE	N	29	212	10	28		7	286
	%	10.1	74.1	3.5	9.8		2.4	99.9
3 EP	N	13	340	14	60		10	437
	%	3.0	77.8	3.2	13.7		2.3	100.0
4 NP	N	52	299	19	54		19	443
	%	11.7	67.5	4.3	12.2		4.3	100.0
5A P	N	20	48	2	5		2	77
	%	26.0	62.3	2.6	6.5		2.6	100.0
5B P	N	10	87	3	13		5	118
	%	8.5	73.7	2.5	11.0		4.2	99.9
5 P+F	N	30	135	5	18		7	195
	%	15.4	69.2	2.6	9.2		3.6	100.0
6 CM	N	134	662	49	120		40	1023
	%	13.1	[illegible]	[illegible]	[illegible]		4.0	100.0
7 S+P	N	[illegible]	[illegible]	[illegible]	12		4	157
	%	[illegible]	[illegible]	[illegible]	7.6		2.5	99.9
8 BIO	N	4	[illegible]	[illegible]	10		3	53
	%	7.5	[illegible]	[illegible]	18.9		5.7	100.1
9 OPT	N	87	98	15	26		7	233
	%	37.3	42.1	6.4	11.2		3.0	100.0
10 ACOUS	N	31	29	2	4		1	67
	%	46.3	43.3	3.0	6.0		1.5	100.1
11-13 ASTRON	N	21	99	4	18		3	145
	%	14.5	68.3	2.8	12.4		2.1	100.1
14 MISC	N	297	338	33	142		47	857
	%	34.7	39.4	3.9	16.6		5.5	100.1
TOTAL	N	739	2396	160	507		152	3954
	%	18.7	60.6	4.0	12.8		3.8	99.9

*70 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - NON-STUDENT+UNKNOWN
PHD OR NOT - PHD
SEX - MALE + UNKNOWN

		EMPLOYMENT STATUS						
SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER OR N.R.	TOTAL
1 A&M	N	241	3	3		1		248
	%	97.2	1.2	1.2		.4		100.0
2 AAA	N	1036	12	25	1	3	2	1079
	%	96.0	1.1	2.3	.1	.3	.2	100.0
3 EP	N	1348	18	14	1	5	11	1394
	%	96.9	1.3	1.0	.1	.4	.8	100.1
4 NP	N	1725	15	28	2	2	7	1779
	%	97.0	.8	1.6	.1	.1	.4	100.0
5A P	N	553	7	3		2	6	573
	%	96.5	1.2	.4		.3	1.0	99.9
5B P	N	516	9	7			2	534
	%	96.6	1.7	1.3			.4	100.0
5 P&P	N	1069	16	12		2	8	1107
	%	96.6	1.4	1.1		.2	.7	100.0
6 CM	N	4010	48	42	5	12	17	4134
	%	97.0	1.2	1.0	.1	.3	.4	100.0
7 S&P	N	686	8	3		5	7	709
	%	96.8	1.1	.4		.7	1.0	100.0
8 BIO	N	234	8		1	2	2	247
	%	94.7	3.2		.4	.8	.8	99.9
9 OPT	N	1065	18	12	1	14	3	1113
	%	95.7	1.6	1.1	.1	1.3	.3	100.0
10 ACOUS	N	307	11	2		5	2	327
	%	93.9	3.4	.6		1.5	.6	100.0
11-13 ASTRON	N	580	9	3	1	2	2	597
	%	97.2	1.5	.5	.2	.3	.3	100.0
16 MISC	N	3257	78	27	6	43	31	3442
	%	94.6	2.3	.8	.2	1.3	.9	100.0
TOTAL	N	15550	235	172	17	96	93	16163
	%	96.2	1.5	1.1	.1	.6	.6	100.1

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079 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - NON-STUDENT+UNKNOWN
PHD OR NOT - PHD
SEX - FEMALE

		EMPLOYMENT STATUS						
SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER N.R.	TOTAL
1 AGR	N	4	2					6
	%	66.7	33.3					100.0
2 AME	N	10	2	2	1			15
	%	66.7	13.3	13.3	6.7			100.0
3 EP	N	29	4	2	1			36
	%	80.6	11.1	5.6	2.8			100.1
4 MP	N	24	4	1	1	1		31
	%	77.4	12.9	3.2	3.2	3.2		99.9
5A P	N	4				1		5
	%	80.0				20.0		100.0
5B P	N	3						3
	%	100.0						100.0
5 P+F	N	7				1		8
	%	87.5				12.5		100.0
6 CP	N	46	11	4	3	2		66
	%	69.7	16.7	6.1	4.5	3.0		100.0
7 SOP	N	7	3	1			1	12
	%	58.3	25.0	8.3			8.3	99.9
8 BIO	N	8						8
	%	100.0						100.0
9 OPT	N	11	1	1	1			14
	%	78.6	7.1	7.1	7.1			99.9
10 ACOUS	N	4						4
	%	100.0						100.0
11-15 ASTRON	N	31	8	2				41
	%	75.6	19.5	4.9				100.0
16 MISC	N	71	18	2	7	3		101
	%	70.3	17.8	2.0	6.9	3.0		100.0
TOTAL	N	252	53	15	14	7	1	342
	%	73.7	15.5	4.4	4.1	2.0	.3	100.0

019 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - NON-STUDENT+UNKNOWN
PHD OR EQT - NO PHD
SEX - MALE + UNKNOWN

SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER OR N.R.	TOTAL
1 A+M	N	30	27	4	13		2	76
	%	39.5	35.5	5.3	17.1		2.6	100.0
2 AML	N	378	115	24	30		11	558
	%	67.7	20.6	4.3	5.4		2.0	100.0
3 EP	N	128	184	23	46		19	400
	%	32.0	46.0	5.8	11.5		4.8	100.1
4 NP	N	834	175	29	53		20	1111
	%	75.1	15.8	2.6	4.8		1.8	100.1
5A P	N	299	23	6	8	1	4	341
	%	87.7	6.7	1.8	2.3	.3	1.2	100.0
5B P	N	102	36	6	11		2	157
	%	65.0	22.9	3.8	7.0		1.3	100.0
5 P+F	N	401	59	12	19	1	6	498
	%	80.5	11.8	2.4	3.8	.2	1.2	99.9
6 CM	N	1924	336	91	111	1	38	2501
	%	76.9	13.4	3.6	4.4		1.5	99.8
7 S+P	N	438	67	11	13		5	534
	%	82.0	12.5	2.1	2.4		.9	99.9
8 BIO	N	95	15	4	8		2	124
	%	76.6	12.1	3.2	6.5		1.6	100.0
9 OPT	N	1744	69	44	23	8	15	1903
	%	91.6	3.6	2.3	1.2	.4	.8	99.9
10 ACOUS	N	654	20	6	2	5	6	693
	%	94.4	2.9	.9	.3	.7	.9	100.1
11-13 ASTRON	N	238	45	9	15		6	313
	%	76.0	14.4	2.9	4.8		1.9	100.0
14 MISC	N	5583	235	102	165	30	90	6205
	%	90.0	3.8	1.6	2.7	.5	1.5	100.1
TOTAL	N	12447	1347	359	498	45	220	14916
	%	83.4	9.0	2.4	3.3	.3	1.5	99.9

079 EMPLOYMENT STATUS BY EMPLOYMENT SPECIALTY BY SEX BY DEGREE
STUDENT STATUS - NON-STUDENT+UNKNOWN
PHD OR NOT = NO PHD
SEX - FEMALE

		EMPLOYMENT STATUS						
SPEC. OF EMPLOYMENT		FULL TIME	PART TIME	UNEMP SEEK	UNEMP NOT SEEK	RET	OTHER +N.R.	TOTAL
1 AGR	N		1	2				3
	%		33.3	66.7				100.0
2 APL	N	6	7	2	3			18
	%	33.3	38.9	11.1	16.7			100.0
3 EP	N	2	8		3			13
	%	15.4	61.5		23.1			100.0
4 HP	N	18	4	1	4			27
	%	66.7	14.8	3.7	14.8			100.1
3A P	N	3		1				4
	%	75.0		25.0				100.0
3B P	N	1						1
	%	100.0						100.0
5 P+R	N	4		1				5
	%	80.0		20.0				100.0
6 CH	N	37	15	6	12		2	72
	%	51.4	20.8	8.3	16.7		2.8	100.0
7 S+P	N	24	4	2	2	1		33
	%	72.7	12.1	6.1	6.1	3.0		100.0
8 BIO	N	6	3	1			1	11
	%	54.5	27.3	9.1			9.1	100.0
9 GPY	N	18	6	7	1		1	33
	%	54.5	18.2	21.2	3.0		3.0	99.9
10 ACUST	N	4	1	1	5			11
	%	36.4	9.1	9.1	45.5			100.1
11-15 ASTRON	N	15	9	1	5	1		31
	%	48.4	29.0	3.2	16.1	3.2		99.9
16 MISC	N	360	75	21	103	4	9	576
	%	62.5	13.0	3.6	17.9	.7	1.7	100.1
TOTAL	N	496	138	45	135	6	11	831
	%	59.7	16.6	5.4	16.2	.7	1.3	99.9

EMP SPEC = 1 AAS

TYPE OF EMPLOYER - TOTAL KNOWN

A77

FIELD OF PHD

BASIC RES	N		108	52	4	1	4	169
	H		63.9	30.8	2.4	.6	2.4	100.1
	V		61.0	82.5	66.7	100.0	100.0	67.1
APPLIED RES	N		6		1			7
	H		85.7		14.3			100.0
	V		3.4		16.7			2.8
DEVEL+DESIGN	N		1					1
	H		100.0					100.0
	V		.6					.4
MANAG - R+D	N		10	2				12
	H		83.3	16.7				100.0
	V		5.6	3.2				4.8
MANAG - OTHER	N		3					3
	H		100.0					100.0
	V		1.7					1.2
TEACHING	N		44	8	1			53
	H		83.0	15.1	1.9			100.0
	V		24.9	12.7	16.7			21.0
OTHER KNOWN	N		2					2
	H		100.0					100.0
	V		1.1					.8
NO RESPONSE	N	1	3	1				5
	H	20.0	60.0	20.0				100.0
	V	100.0	1.7	1.6				2.0
TOTAL	N	1	177	63	6	1	4	252
	H	.4	70.2	25.0	2.4	.4	1.6	100.0
	V	100.0	100.0	100.0	100.1	100.0	100.0	100.1

*T10 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY

A78

EMP SPEC - 2 AME

TYPE OF EMPLOYER - TOTAL KNOWN

FIELD OF PHD

PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNG	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	85		380	6	2	2	21	3	7	506
	H	16.8		75.1	1.2	.4	.4	4.2	.6	1.4	100.1
	V	61.6		45.8	60.0	66.7	66.7	30.4	100.0	70.0	47.5
APPLIED RES	N	15		110	1		1	20		1	148
	H	10.1		74.3	.7		.7	13.5		.7	100.0
	V	10.9		13.3	10.0		33.3	29.0		10.0	13.9
DEVEL+DESIGN	N	1		11				6			18
	H	5.6		61.1				33.3			100.0
	V	.7		1.3				8.7			1.7
MANAG - R+D	N	9		64	1			8			82
	H	11.0		78.0	1.2			9.8			100.0
	V	6.5		7.7	10.0			11.6			7.7
MANAG - OTHER	N			23				2			25
	H			92.0				8.0			100.0
	V			2.8				2.9			2.3
TEACHING	N	23		212	2	1		9		1	248
	H	9.3		85.5	.8	.4		3.6		.4	100.0
	V	16.7		25.6	20.0	33.3		13.0		10.0	23.3
OTHER KNOWN	N	2		8				3		1	14
	H	14.3		57.1				21.4		7.1	99.9
	V	1.4		1.0				4.3		10.0	1.3
NO RESPONSE	N	3		21							24
	H	12.5		87.5							100.0
	V	2.2		2.5							2.3
TOTAL	N	138		829	10	3	3	69	3	10	1065
	H	13.0		77.8	.9	.3	.3	6.5	.3	.9	100.0
	V	100.0		100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0

EMP SPEC - 3 AP
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A79

		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNG	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	2		917	2	3		1	1	9	935
	H	.2		98.1	.2	.3		.1	.1	1.0	100.0
	V	66.7		66.9	66.7	100.0		12.5	50.0	81.8	66.4
APPLIED RES	N	1		42				3	1		47
	H	2.1		89.4				6.4	2.1		100.0
	V	33.3		3.1				37.5	50.0		3.3
DEVEL+DESIGN	N			14				2			16
	H			87.5				12.5			100.0
	V			1.0				25.0			1.1
MANAG - R+D	N			70				1			71
	H			98.6				1.4			100.0
	V			5.1				12.5			5.0
MANAG - OTHER	N			18							18
	H			100.0							100.0
	V			1.3							1.3
TEACHING	N			270	1		1	1		1	274
	H			98.5	.4		.4	.4		.4	100.1
	V			19.7	33.3		100.0	12.5		9.1	19.4
OTHER KNOWN	N			8						1	9
	H			88.9						11.1	100.0
	V			.6						9.1	.6
NO RESPONSE	N			29							29
	H			100.0							100.0
	V			2.1							2.1
TOTAL	N	3		1370	3	3	1	8	2	11	1409
	H	.2		97.2	.2	.2	.1	.6	.1	.8	100.0
	V	100.0		99.9	100.0	100.0	100.0	100.0	100.0	100.0	99.9

*T10 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY
EMP SPEC - 4 AP
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A80

PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNG	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	15		681		2	4	9	2	8	721
	H	2.1		94.5		.3	.6	1.2	.3	1.1	100.1
	V	48.4		42.2		66.7	9.5	13.0	18.2	80.0	40.5
APPLIED RES	N	5		209	1	1	12	26	3		257
	H	1.9		81.3	.4	.4	4.7	10.1	1.2		100.0
	V	16.1		12.9	50.0	33.3	28.6	37.7	27.3		14.4
DEVEL+DESIGN	N			38			2	7			47
	H			80.9			4.3	14.9			100.1
	V			2.4			4.8	10.1			2.6
MANAG - R+D	N	4		182			4	7			197
	H	2.0		92.4			2.0	3.6			100.0
	V	12.9		11.3			9.5	10.1			11.1
MANAG - OTHER	N	1		61			5	1	1		69
	H	1.4		88.4			7.2	1.4	1.4		99.8
	V	3.2		3.8			11.9	1.4	9.1		3.9
TEACHING	N	6		375	1		10	16	3	2	413
	H	1.5		90.8	.2		2.4	3.9	.7	.5	100.0
	V	19.4		23.2	50.0		23.8	23.2	27.3	20.0	23.2
OTHER KNOWN	N			30			4	2	2		38
	H			78.9			10.5	5.3	5.3		100.0
	V			1.9			9.5	2.9	18.2		2.1
NO RESPONSE	N			38			1	1			40
	H			95.0			2.5	2.5			100.0
	V			2.4			2.4	1.4			2.2
TOTAL	N	31		1614	2	3	42	69	11	10	1782
	H	1.7		90.6	.1	.2	2.4	3.9	.6	.6	100.1
	V	100.0		100.1	100.0	100.0	100.0	99.9	100.1	100.0	100.0

EMP SPEC - 5A P
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A81

BASIC RES	N	6		81	6	8		45	2	2	150
	H	4.0		54.0	4.0	5.3		30.0	1.3	1.3	99.9
	V	50.0		27.6	75.0	57.1		20.3	14.3	33.3	26.3
APPLIED RES	N	2		92		1		54	3	2	154
	H	1.3		59.7		.6		35.1	1.9	1.3	99.9
	V	16.7		31.3		7.1		24.3	21.4	33.3	27.0
DEVEL-DESIGN	N	1		10				2			13
	H	7.7		76.9				15.4			100.0
	V	8.3		3.4				.9			2.3
MANAG - R+D	N	2		39	1	1		32	1		76
	H	2.6		51.3	1.3	1.3		42.1	1.3		99.9
	V	16.7		13.3	12.5	7.1		14.4	7.1		13.3
MANAG - OTHER	N			3				4	1		8
	H			37.5				50.0	12.5		100.0
	V			1.0				1.8	7.1		1.4
TEACHING	N	1		59	1	4		75	5	2	147
	H	.7		40.1	.7	2.7		51.0	3.4	1.4	100.0
	V	8.3		20.1	12.5	28.6		33.8	35.7	33.3	25.8
OTHER KNOWN	N			4				3			7
	H			57.1				42.9			100.0
	V			1.4				1.4			1.2
NO RESPONSE	N			6				7	2		15
	H			40.0				46.7	13.3		100.0
	V			2.0				3.2	14.3		2.6
TOTAL	N	12		294	8	14		222	14	6	570
	H	2.1		51.6	1.4	2.5		38.9	2.5	1.1	100.1
	V	100.0		100.1	100.0	99.9		100.1	99.9	99.9	99.9

0710 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY PAGE- 21
EMP SPEC - 5B P
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A82

PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNR	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	2		194	3			32	2		233
	H	.9		83.3	1.3			13.7	.9		100.1
	V	28.6		46.9	50.0			32.0	40.0		43.6
APPLIED RES	N	2		80				32	1	1	116
	H	1.7		69.0				27.6	.9	.9	100.1
	V	28.6		19.3				32.0	20.0	50.0	21.7
DEVEL-DESIGN	N			3							3
	H			100.0							100.0
	V			.7							.6
MANAG - R+D	N	1		49				4	1		55
	H	1.8		89.1				7.3	1.8		100.0
	V	14.3		11.8				4.0	20.0		10.3
MANAG - OTHER	N			4							4
	H			100.0							100.0
	V			1.0							.7
TEACHING	N	2		72	2			31	1	1	109
	H	1.8		66.1	1.8			28.4	.9	.9	99.9
	V	28.6		17.4	33.3			31.0	20.0	50.0	20.4
OTHER KNOWN	N										
	H										
	V										
NO RESPONSE	N			12	1			1			14
	H			85.7	7.1			7.1			99.9
	V			2.9	16.7			1.0			2.6
TOTAL	N	7		414	6			100	5	2	534
	H	1.3		77.5	1.1			18.7	.9	.4	99.9
	V	100.1		100.0	100.0			100.0	100.0	100.0	99.9

282

EMP SPEC - 5 P+P
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A83

BASIC RES	N	8		276	9	8		77	4	2	384
	H	2.1		71.9	2.3	2.1		20.1	1.0	.5	99.9
	V	42.1		38.9	64.3	57.1		23.9	21.1	25.0	34.7
APPLIED RES	N	4		172		1		86	4	3	270
	H	1.5		63.7		.4		31.9	1.5	1.1	100.1
	V	21.1		24.3		7.1		26.7	21.1	37.5	24.3
DEVEL+DESIGN	N	1		13				2			16
	H	6.3		81.3				12.5			100.1
	V	5.3		1.8				.6			1.4
MANAG - R+D	N	3		88	1	1		36	2		131
	H	2.3		67.2	.8	.8		27.5	1.5		100.1
	V	15.8		12.4	7.1	7.1		11.2	10.5		11.8
MANAG - OTHER	N			7				4	1		12
	H			58.3				33.3	8.3		99.9
	V			1.0				1.2	5.3		1.1
TEACHING	N	3		131	3	4		106	6	3	256
	H	1.2		51.2	1.2	1.6		41.4	2.3	1.2	100.1
	V	15.8		18.5	21.4	28.6		32.9	31.6	37.5	23.2
OTHER KNOWN	N			4				3			7
	H			57.1				42.9			100.0
	V			.6				.9			.6
NO RESPONSE	N			18	1			8	2		29
	H			62.1	3.4			27.6	6.9		100.0
	V			2.5	7.1			2.5	10.5		2.6
TOTAL	N	19		709	14	14		322	19	8	1109
	H	1.7		64.3	1.3	1.3		29.2	1.7	.7	100.0
	V	100.1		99.9	99.9	99.9		99.9	100.1	100.0	100.0

*T10 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY
EMP SPEC - 6 CP
TYPE OF EMPLOYER - TOTAL KNOWN

A84

		FIELD OF PHD									
PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNR	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	97		1313	2	3	5	130	8	16	1574
	H	6.2		83.4	.1	.2	.3	8.3	.5	1.0	100.0
	V	52.2		39.2	33.3	27.3	62.5	24.2	22.2	72.7	37.9
APPLIED RES	N	33	2	641	4	1		186	14	2	883
	H	3.7	.2	72.6	.5	.1		21.1	1.6	.2	100.0
	V	17.7	66.7	19.2	66.7	9.1		34.6	38.9	9.1	21.2
DEVEL+DESIGN	N	2		81				15			98
	H	2.0		82.7				15.3			100.0
	V	1.1		2.4				2.8			2.4
MANAG - R+D	N	26	1	344		1		81	2		455
	H	5.7	.2	75.6		.2		17.8	.4		99.9
	V	14.0	33.3	10.3		9.1		15.1	5.6		10.9
MANAG - OTHER	N	4		93		1		14	4		116
	H	3.4		80.2		.9		12.1	3.4		100.0
	V	2.2		2.8		9.1		2.6	11.1		2.8
TEACHING	N	19		757		5	3	98	7	4	893
	H	2.1		84.8		.6	.3	11.0	.8	.4	100.0
	V	10.2		22.6		45.5	37.5	18.2	19.4	18.2	21.5
OTHER KNOWN	N	2		40				10			52
	H	3.8		76.9				19.2			99.9
	V	1.1		1.2				1.9			1.3
NO RESPONSE	N	3		78				4	1		86
	H	3.5		90.7				4.7	1.2		100.1
	V	1.6		2.3				.7	2.8		2.1
TOTAL	N	186	3	3347	6	11	8	538	36	22	4157
	H	4.5	.1	80.5	.1	.3	.2	12.9	.9	.5	100.0
	V	100.1	100.0	100.0	100.0	100.1	100.0	100.1	100.0	100.0	100.1

EMP SPEC - 7 SEP
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A85

BASIC RES	N	3	4	256	31	7		23	2	2	328
	H	.9	1.2	78.0	9.5	2.1		7.0	.6	.6	99.9
	V	37.5	50.0	46.1	54.4	77.8		38.3	25.0	40.0	46.1
APPLIED RES	N	3		112	6			15			136
	H	2.2		82.4	4.4			11.0			100.0
	V	37.5		20.2	10.5			25.0			19.1
DEVEL+DESIGN	N			8				2			10
	H			80.0				20.0			100.0
	V			1.4				3.3			1.4
MANAG - R+D	N		1	83	8	2	1	12		2	109
	H		.9	76.1	7.3	1.8	.9	11.0		1.8	99.8
	V		12.5	15.0	14.0	22.2	50.0	20.0		40.0	15.3
MANAG - OTHER	N		1	9	1			1	1		13
	H		7.7	69.2	7.7			7.7	7.7		100.0
	V		12.5	1.6	1.8			1.7	12.5		1.8
TEACHING	N	1	1	61	9			4	4	1	81
	H	1.2	1.2	75.3	11.1			4.9	4.9	1.2	99.8
	V	12.5	12.5	11.0	15.8			6.7	50.0	20.0	11.4
OTHER KNOWN	N			16	2		1		1		20
	H			80.0	10.0		5.0		5.0		100.0
	V			2.9	3.5		50.0		12.5		2.8
NO RESPONSE	N	1	1	10				3			15
	H	6.7	6.7	66.7				20.0			100.1
	V	12.5	12.5	1.8				5.0			2.1
TOTAL	N	8	8	555	57	9	2	60	8	5	712
	H	1.1	1.1	77.9	8.0	1.3	.3	8.4	1.1	.7	99.9
	V	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

OT10 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY
EMP SPEC - 8 BIO
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

A86

PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNR	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	6		93		2	44	9	4		158
	H	3.8		58.9		1.3	27.8	5.7	2.5		100.0
	V	60.0		56.4		100.0	62.9	47.4	57.1		57.7
APPLIED RES	N	1		9	1		2	6	1		20
	H	5.0		45.0	5.0		10.0	30.0	5.0		100.0
	V	10.0		5.5	100.0		2.9	31.6	14.3		7.3
DEVEL+DESIGN	N			2			1	1			4
	H			50.0			25.0	25.0			100.0
	V			1.2			1.4	5.3			1.5
MANAG - R+D	N	1		17			1	2	1		22
	H	4.5		77.3			4.5	9.1	4.5		99.9
	V	10.0		10.3			1.4	10.5	14.3		8.0
MANAG - OTHER	N			4							4
	H			100.0							100.0
	V			2.4							1.5
TEACHING	N	2		33			21	1			57
	H	3.5		57.9			36.8	1.8			100.0
	V	20.0		20.0			30.0	5.3			20.8
OTHER KNOWN	N			5							5
	H			100.0							100.0
	V			3.0							1.8
NO RESPONSE	N			2			1		1		4
	H			50.0			25.0		25.0		100.0
	V			1.2			1.4		14.3		1.5
TOTAL	N	10		165	1	2	70	19	7		274
	H	3.6		60.2	.4	.7	25.5	6.9	2.6		99.9
	V	100.0		100.0	100.0	100.0	100.0	100.1	100.0		100.1

A87

EMP SPEC - 9 OPT
TYPE OF EMPLOYER - TOTAL KNOWN
FIELD OF PHD

BASIC RES	N	15	1	160	5		3	20	1		205
	H	7.3	.5	78.0	2.4		1.5	9.8	.5		100.0
	V	57.7	100.0	19.0	29.4		37.5	12.3	11.1		19.0
APPLIED RES	N	2		276	4			71	3	6	362
	H	.6		76.2	1.1			19.6	.8	1.7	100.0
	V	7.7		32.8	23.5			43.8	33.3	66.7	33.6
DEVEL+DESIGN	N			46	1	1		7		1	56
	H			82.1	1.8	1.8		12.5		1.8	100.0
	V			5.5	5.9	25.0		4.3		11.1	5.2
MANAG - R+D	N	7		168	3			31	2		211
	H	3.3		79.6	1.4			14.7	.9		99.9
	V	26.9		20.0	17.6			19.1	22.2		19.6
MANAG - OTHER	N			28				8			36
	H			77.8				22.2			100.0
	V			3.3				4.9			3.3
TEACHING	N	2		118	3	2	5	19	1	1	151
	H	1.3		78.1	2.0	1.3	3.3	12.6	.7	.7	100.0
	V	7.7		14.0	17.6	50.0	62.5	11.7	11.1	11.1	14.0
OTHER KNOWN	N			26	1	1		3	2		33
	H			78.8	3.0	3.0		9.1	6.1		100.0
	V			3.1	5.9	25.0		1.9	22.2		3.1
NO RESPONSE	N			20				3		1	24
	H			83.3				12.5		4.2	100.0
	V			2.4				1.9		11.1	2.2
TOTAL	N	26	1	842	17	4	8	162	9	9	1078
	H	2.4	.1	78.1	1.6	.4	.7	15.0	.8	.8	99.9
	V	100.0	100.0	100.1	99.9	100.0	100.0	99.9	99.9	100.0	100.0

A88

0710 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY
EMP SPEC - 10 ACOUST
TYPE OF EMPLOYER - TOTAL KNOWN

PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGNG	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	1		26			1	10	1		39
	H	2.6		66.7			2.6	25.6	2.6		100.1
	V	25.0		11.5			100.0	13.5	9.1		12.0
APPLIED RES	N	1	1	72		3		24	4	1	106
	H	.9	.9	67.9		2.8		22.6	3.8	.9	99.8
	V	25.0	50.0	31.7		75.0		32.4	36.4	100.0	32.7
DEVEL+DESIGN	N			13				2	1		16
	H			81.3				12.5	6.3		100.1
	V			5.7				2.7	9.1		4.9
MANAG - R+D	N	1	1	54		1		11			68
	H	1.5	1.5	79.4		1.5		16.2			100.1
	V	25.0	50.0	23.8		25.0		14.9			21.0
MANAG - OTHER	N			4				2	1		7
	H			57.1				28.6	14.3		100.0
	V			1.8				2.7	9.1		2.2
TEACHING	N	1		38				16	4		59
	H	1.7		64.4				27.1	6.8		100.0
	V	25.0		16.7				21.6	36.4		18.2
OTHER KNOWN	N			12				6			18
	H			66.7				33.3			100.0
	V			5.3				8.1			5.6
NO RESPONSE	N			8				3			11
	H			72.7				27.3			100.0
	V			3.5				4.1			3.4
TOTAL	N	4	2	227		4	1	74	11	1	324
	H	1.2	.6	70.1		1.2	.3	22.8	3.4	.3	99.9
	V	100.0	100.0	100.0		100.0	100.0	100.0	100.1	100.0	100.0

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0710 FIELD OF PHD BY PRIMARY WORK ACTIVITY BY EMPLOYER AND EMPLOYMENT SPECIALTY
EMP SPEC - 16 MISC
TYPE OF EMPLOYER - TOTAL KNOWN

PRIMARY ACTIVITY		CHEM	EARTH SCI	PHYS	ASTRO	MATH	BIOL	ENGIN	OTHER KNOWN	NO RESP	TOTAL
BASIC RES	N	20	1	162	9	5	2	9	5	5	218
	H	9.2	.5	74.3	4.1	2.3	.9	4.1	2.3	2.3	100.0
	V	19.8	11.1	5.9	10.2	15.2	14.3	3.2	2.7	26.3	6.3
APPLIED RES	N	10	3	328	1	8	2	75	8	1	436
	H	2.3	.7	75.2	.2	1.8	.5	17.2	1.8	.2	99.9
	V	9.9	33.3	12.0	1.1	24.2	14.3	26.8	4.4	5.3	12.6
DEVEL+DESIGN	N	2		63	1	1	1	10	2		80
	H	2.5		78.8	1.3	1.3	1.3	12.5	2.5		100.2
	V	2.0		2.3	1.1	3.0	7.1	3.6	1.1		2.3
MANAG - R+D	N	15	2	420	5	3		58	7	1	511
	H	2.9	.4	82.2	1.0	.6		11.4	1.4	.2	100.1
	V	14.9	22.2	15.4	5.7	9.1		20.7	3.8	5.3	14.8
MANAG - OTHER	N	8		288	4	3	1	23	29	4	360
	H	2.2		80.0	1.1	.8	.3	6.4	8.1	1.1	100.0
	V	7.9		10.5	4.5	9.1	7.1	8.2	15.8	21.1	10.4
TEACHING	N	38	3	1257	62	11	8	84	124	7	1594
	H	2.4	.2	78.9	3.9	.7	.5	5.3	7.8	.4	100.1
	V	37.6	33.3	46.0	70.5	33.3	57.1	30.0	67.8	36.8	46.1
OTHER KNOWN	N	6		156	4	1		17	5	1	190
	H	3.2		82.1	2.1	.5		8.9	2.6	.5	99.9
	V	5.9		5.7	4.5	3.0		6.1	2.7	5.3	5.5
NO RESPONSE	N	2		56	2	1		4	3		68
	H	2.9		82.4	2.9	1.5		5.9	4.4		100.0
	V	2.0		2.1	2.3	3.0		1.4	1.6		2.0
TOTAL	N	101	9	2730	88	33	14	280	183	19	3457
	H	2.9	.3	79.0	2.5	1.0	.4	8.1	5.3	.5	100.0
	V	100.0	99.9	99.9	99.9	99.9	99.9	100.0	99.9	100.1	100.0

EMP SPEC - TOTAL
TYPE OF EMPLOYER - TOTAL KNOWN

A90

FIELD OF PHD

BASIC RES	N	253	6	4516	324	36	61	323	33	55	5602
	H	4.5	.1	80.5	5.8	.6	1.1	5.8	.6	1.0	100.0
	V	47.8	26.1	35.3	51.8	38.7	40.9	19.8	11.3	52.4	34.5
APPLIED RES	N	76	6	1995	42	15	17	518	38	14	2721
	H	2.8	.2	73.3	1.5	.6	.6	19.0	1.4	.5	99.9
	V	14.4	26.1	15.6	6.7	16.1	11.4	31.8	13.0	13.3	16.7
DEVEL+DESIGN	N	6		296	3	2	4	54	4	1	370
	H	1.6		80.0	.8	.5	1.1	14.6	1.1	.3	100.0
	V	1.1		2.3	.5	2.2	2.7	3.3	1.4	1.0	2.3
MANAG - R+D	N	66	5	1525	59	8	6	251	14	6	1940
	H	3.4	.3	78.6	3.0	.4	.3	12.9	.7	.3	99.9
	V	12.5	21.7	11.9	9.4	8.6	4.0	15.4	4.8	5.7	11.9
MANAG - OTHER	N	13	1	542	11	4	6	55	37	4	673
	H	1.9	.1	80.5	1.6	.6	.9	8.2	5.5	.6	99.9
	V	2.5	4.3	4.2	1.8	4.3	4.0	3.4	12.6	3.8	4.1
TEACHING	N	95	4	3318	169	24	48	360	149	20	4187
	H	2.3	.1	79.2	4.0	.6	1.1	8.6	3.6	.5	100.0
	V	18.0	17.4	25.9	27.0	25.8	32.2	22.1	50.9	19.0	25.8
OTHER KNOWN	N	10		313	10	2	5	44	11	2	398
	H	2.5		78.6	2.5	.5	1.3	11.1	2.8	.5	100.1
	V	1.9		2.4	1.6	2.2	3.4	2.7	3.8	1.9	2.4
NO RESPONSE	N	10	1	295	7	2	2	26	7	2	352
	H	2.8	.3	83.8	2.0	.6	.6	7.4	2.0	.6	100.1
	V	1.9	4.3	2.3	1.1	2.2	1.3	1.6	2.4	1.9	2.2
TOTAL	N	529	23	12800	625	93	149	1631	293	105	16248
	H	3.3	.1	78.8	3.8	.6	.9	10.0	1.8	.6	99.9
	V	100.1	99.9	99.9	99.9	100.1	99.9	100.1	100.2	100.0	99.9

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ACADEMIC RANK BY AGE, EMPLOYMENT SPECIALTY AND DEGREE

DIMENSION-001 01
DIMENSION-002 [illegible]
DIMENSION-003 EMP SPEC: TOTAL ALL PANEL GROUPS

ACADEMIC RANK		UNDER 20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	OVER [illegible]	TOTAL	NO RESP.
DEAN	MD 50= 49.7					1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
FULL PROF	MD 50= 44.9		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ASSOC PROF	MD 50= 37.5		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ASST PROF	MD 50= 32.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
INSTRUCTOR	MD 50= 30.5	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	
LECTURER	MD 50= 33.7		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
RES ASST	MD 50= 30.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
ASST	MD 50= 28.9		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]			[illegible]	[illegible]
OTHER	MD 50= 30.9		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]					[illegible]	
NO RESPONSE	MD 50= 37.7		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	MD 50= 37.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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DIMENSION-001 01
DIMENSION-002 [illegible] PHD
DIMENSION-003 EMP SPEC: TOTAL ALL PANEL GROUPS

DEAN	MD 50= 38.7				[illegible]		[illegible]	[illegible]		[illegible]				[illegible]	
FULL PROF	MD 50= 52.1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
ASSOC PROF	MD 50= 44.0		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	
ASST PROF	MD 50= 35.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
INSTRUCTOR	MD 50= 31.3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LECTURER	MD 50= 32.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	
RES ASST	MD 50= 29.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]	
ASST	MD 50= 27.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]
OTHER	MD 50= 28.1	[illegible]	[illegible]	[illegible]			[illegible]	[illegible]		[illegible]				[illegible]	
NO RESPONSE	MD 50= 33.1	100.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TOTAL	MD 50= 37.2	100.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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*T12 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASIS: UNIV - 9 MOS.
                                      SALARY (IN THOUSANDS)
                      UNDER  8.0-  11.0-  14.0-  17.0-  20.0-  25.0-           NO    TOTAL
INCOME                  8.0  10.9   13.9   16.9   19.9   24.9   34.9  35.0+  RESP.  KNOWN
UNDER 8,000       N  [illegible]                                 [illegible]          13
                  H  [illegible]  23.[illegible]  23.[illegible]  7.[illegible]       100.0
                  V  37.5
                  MP   25=  4.3     50=  [illegible]     75= 11.8
8-10,900          N                                                                   211
                  H  [illegible]
                  V  50.0  33.2
                  MP   25=  8.7     50=  9.5     75= 10.3
11-13,900         N  [illegible]                                                      [illegible]
                  H  [illegible]
                  V  [illegible]
                  MP   25= 10.0     50= 11.6     75= [illegible]
14-16,900         N  [illegible]                                                      1079
                  H  [illegible]
                  V  7.4   50.3
                  MP   25= 11.9     50= 12.9     75= 13.9
17-19,900         N  [illegible]                                                      612
                  H  [illegible]
                  V  [illegible]
                  MP   25= 14.0     50= 15.3     75= [illegible]
20-24,900         N  [illegible]                                                      699
                  H  [illegible]
                  V  [illegible]
                  MP   25= 15.8     50= 17.0     75= 19.4
25-34,900         N  [illegible]                                                      477
                  H  [illegible]
                  V  [illegible]
                  MP   25= 19.9     50= 22.0     75= 24.1
35,000+           N  [illegible]                                                      [illegible]
                  H  [illegible]
                  V  [illegible]
                  MP   25= 23.6     50= 27.9     75= [illegible]
NO RESPONSE       N  [illegible]
                  H  26.[illegible]  33.[illegible]  19.0  [illegible]  3.[illegible]  [illegible]  100.0
                  MP   25= 10.9     50= [illegible]  75= [illegible]
TOTAL KNOWN       N  [illegible]                                                      4129
                  H  [illegible]  14.4  [illegible]  20.9  [illegible]  10.2  3.3  .1  100.0
                  MP   25= 11.0     50= 13.0     75= 17.3
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A94

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DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASIS: UNIV - 12 MOS.
UNDER 8,000       N  135    [illegible]  [illegible]                          140   [illegible]
                  H  93.8   4.2   2.1
                  V  90.0   .9    .4                                          45.6  4.3
                  MP   25=  2.1     50=  [illegible]     75=  [illegible]
8-10,900          N  [illegible]  585                                          37   603
                  H  [illegible]  97.0
                  V  [illegible]  85.9                                         12.1  [illegible]
                  MP   25=  8.7     50=  9.5     75= 10.2
11-13,900         N  72   533                                                 38   609
                  H  11.8  [illegible]
                  V  10.6  72.3                                               12.4  [illegible]
                  MP   25= 11.5     50= 12.3     75= 13.2
14-16,900         N  [illegible]                                               29   610
                  H  [illegible]                                                     100.0
                  V  [illegible]  67.4                                          9.4  [illegible]
                  MP   25= 13.5     50= 14.9     75= 15.9
17-19,900         N  [illegible]                                               19   [illegible]
                  H  [illegible]                                                     100.0
                  V  [illegible]                                               6.2  11.8
                  MP   25= 15.6     50= 17.5     75= 18.7
20-24,900         N  [illegible]  101                                          25   [illegible]
                  H  [illegible]
                  V  [illegible]  66.4                                          8.1  [illegible]
                  MP   25= 18.4     50= 20.9     75= 23.0
25-34,900         N  [illegible]                                               12   [illegible]
                  H  [illegible]
                  V  [illegible]  30.9                                          3.9  12.3
                  MP   25= 22.1     50= 26.0     75= 30.5
35,000+           N  [illegible]  11  58  30                                    7   102
                  H  1.0  2.0  [illegible]  [illegible]  [illegible]
                  V  [illegible]  100.0                                         2.3  [illegible]
                  MP   25= 27.0     50= [illegible]  75= 44.7
NO RESPONSE       N  [illegible]  19  14  2                                   181   [illegible]
                  H  2.[illegible]  24.6  [illegible]  12.5  [illegible]  13.4  9.9  1.4     100.1
                  MP   25= 10.3     50= [illegible]  75= 19.0
TOTAL KNOWN       N  [illegible]  681  [illegible]  641  [illegible]  [illegible]  291  30  307  [illegible]
                  H  [illegible]  20.2  21.9  19.0  [illegible]  13.4  8.6  .9
```

288

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--------------------------------- NP   25= 11.0    50= 14.5    75= 19.5 -------------------------------------
STAT SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE                                          A95
DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: PRIVATE INDUSTRY
                            ------ ------ ------ SALAR Y (IN THOUS ANDS) ------ ------ ------ ------ ------
                            UNDER  8.0-   11.0-  14.0-  17.0-  20.0-  25.0-               NO     TOTAL
INCOME                        8.0   10.9   13.9   16.9   19.9   24.9   34.9   35.0+     RESP.  KNOWN
UNDER 8,000              N                                                                 4  [illegible]
                         V                                                              10.0  100.0
                         NP  25=  2.4      50=  4.8      75=  7.2
8-10,900                 N                                                                 1  [illegible]
                         V                                                               2.9  100.0
                         NP  25=  9.6      50= 10.7      75= 11.8
11-13,900                N                                                                 3  [illegible]
                         V                                                               7.9  100.0
                         NP  25= 11.8      50= 12.7      75= 13.5
14-16,900                N                                                                 6  [illegible]
                         V                                                              15.0  [illegible]
                         NP  25= 14.7      50= 15.5      75= 16.3
17-19,900                N                                                                 8  [illegible]
                         V                                                              20.0  [illegible]
                         NP  25= 17.6      50= 19.4      75= 19.2
20-24,900                N                                                                 8  [illegible]
                         V                                                              20.0  [illegible]
                         NP  25= 20.6      50= 22.1      75= 23.5
25-34,900                N                                                                 9  [illegible]
                         V                                                              22.5  [illegible]
                         NP  25= 26.0      50= 29.0      75= 32.0
35,000+                  N                                                                 1  [illegible]
                         V                                                               2.5  [illegible]
                         NP  25= 32.8      50= 52.9      75= 76.2
NO RESPONSE              N                                                               141  [illegible]
                         NP  25= 18.0      50= [illegible]   75= [illegible]
TOTAL KNOWN              N                                                                40  [illegible]
                         V                                                                    100.0
                         NP  25= 16.0      50= 20.9      75= 25.2
DIMENSION-001  PHD                                                                                           A96
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: GOVERNMENT - FEDERAL ETC.
UNDER 8,000              N                                                                 6  [illegible]
                         V                                                              19.4  100.0
                         NP  25= [illegible]   50=  4.9      75=  7.3
8-10,900                 N                                                                 1  [illegible]
                         V                                                               3.2  [illegible]
                         NP  25=  8.0      50=  9.3      75= 10.6
11-13,900                N                                                                 5  [illegible]
                         V                                                              16.1  [illegible]
                         NP  25= 11.7      50= 12.5      75= 13.2
14-16,900                N                                                                 9  [illegible]
                         V                                                              29.0  [illegible]
                         NP  25= 14.6      50= 15.4      75= 16.2
17-19,900                N                                                                    [illegible]
                         NP  25= 17.5      50= 18.3      75= 19.2
20-24,900                N                                                                 5  [illegible]
                         V                                                              16.1  [illegible]
                         NP  25= 20.9      50= 22.3      75= 23.7
25-34,900                N                                                                 6  [illegible]
                         V                                                              19.4  [illegible]
                         NP  25= 26.5      50= 29.3      75= 32.2
35,000+                  N                                                                    [illegible]
                         NP  25= 28.0      50= 33.5      75= 41.0
NO RESPONSE              N                                                                24  [illegible]
                         V                                                                    100.0
                         NP  25= [illegible]   50= [illegible]   75= [illegible]
TOTAL KNOWN              N                                                                31  [illegible]
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A97

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                    MP   25= 16.0    50= 19.6    75= 24.6
STAT SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: RESEARCH CENTER
                          ----- ----- ----- SALARY (IN THOUS AMOS) ----- ----- -----
                          UNDER  8.0-  11.0-  14.0-  17.0-  20.0-  25.0-            NO    TOTAL
INCOME                     8.0   10.9   13.9   16.9   19.9   24.9   34.9  35.0+  RESP.  INCOME
UNDER 8,000         N   [illegible]                                               3    [illegible]
                        100.0                                                  12.5   100.0
                    MP   25=  2.0    50=  4.0    75=  6.0
8-10,900            N           32                                             1      34
                        [illegible]                                            4.2    [illegible]
                    MP   25=  8.0    50=  9.6    75= 10.6
11-13,900           N            3    145                                      3     149
                        [illegible]                                           12.5    [illegible]
                    MP   25= 11.7    50= 12.5    75= 13.3
14-16,900           N                 [illegible] 228                          5     234
                        [illegible]                                           20.8    [illegible]
                    MP   25= 14.7    50= 15.5    75= 16.2
17-19,900           N                        19    409     1                   1     [illegible]
                        [illegible]                                            4.2    [illegible]
                    MP   25= 17.7    50= 18.5    75= 19.2
20-24,900           N                         1     50    491                  6     [illegible]
                        [illegible]                                           25.0    [illegible]
                    MP   25= 20.9    50= 22.2    75= 23.6
25-34,900           N                                39    219                 4     261
                        [illegible]                                           16.7    [illegible]
                    MP   25= 26.1    50= 29.0    75= 32.0
35,000+             N                                           29             1      34
                        [illegible]                          100.0             4.2   100.0
                    MP   25= 33.3    50= 53.9    75= 76.9
NO RESPONSE         N                  10           25     17     12      1    92      [illegible]
                        2.4          [illegible]   8.0   25.4   25.0   17.6    1.1         99.5
                    MP   25= 14.5    50= 19.4    75= 23.6
TOTAL KNOWN         N       4     35    151    206    544    236    220     29    24    1768
                           [illegible]  2.0  [illegible] 13.9  30.8  34.3  12.9  1.6        100.0
                    MP   25= 17.0    50= 19.3    75= 23.2
```

A98

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DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: OTHER KNOWN
UNDER 8,000         N      36      1                                           18     [illegible]
                         97.3    2.7                                          20.2    [illegible]
                         75.0    1.0
                    MP   25=  2.1    50=  4.1    75=  6.2
8-10,900            N       1     91                                           15     [illegible]
                        [illegible]                                           15.7    [illegible]
                    MP   25=  8.4    50=  9.3    75= 10.1
11-13,900           N           19     81                                      6     [illegible]
                        [illegible]                                            6.7    15.5
                    MP   25= 11.2    50= 12.2    75= 13.1
14-16,900           N            1     18     83                               7     [illegible]
                        [illegible]                                            7.9    15.1
                    MP   25= 14.2    50= 15.2    75= 16.1
17-19,900           N                   2     14     81                        5     [illegible]
                        [illegible]                                            5.6    15.1
                    MP   25= 17.2    50= 18.2    75= 19.1
20-24,900           N                          7     24     93                 9     124
                        [illegible]                                           10.1    [illegible]
                    MP   25= 20.0    50= 21.7    75= 23.3
25-34,900           N                                       28     91          20     [illegible]
                        [illegible]                                           22.5    [illegible]
                    MP   25= 22.1    50= 25.9    75= 30.5
35,000+             N                                        4     12     21   10      31
                        [illegible]                                   100.0   11.2    [illegible]
                    MP   25= 29.4    50= 42.7    75= 71.3
NO RESPONSE         N   [illegible]                                            56     [illegible]
                        [illegible]   6.9   17.5   17.4   21   21.7   4.3   4.3        [illegible]
                    MP   25= 13.1    50= 17.3    75= 21.3
TOTAL KNOWN         N      48    106    108    104    114    123     58     21    89    [illegible]
                        [illegible]  15.2  15.8  15.2  16.2  18.1  [illegible]            [illegible]
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290

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-------------------MP  25= 11.5    50= 16.3    75= 21.Y----------------------------
                                                                                  A99
BT12 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: NO RESPONSE
                          ----- ----- ----- SALARY (IN THOUSANDS) ----- ----- -----
INCOME                    UNDER  8.0-  11.0-  14.0-  17.0-  20.0-  25.0-         NO   TOTAL
                            8.0  10.9  13.9   16.9   19.9   24.9   34.9  35.0+ RESP.  KNOWN
UNDER 8,000                                                                    35
8-10,900                                                                       [illegible]
11-13,900                                                                      [illegible]
14-16,900                                                                      [illegible]
17-19,900                                                                      [illegible]
20-24,900       MP  25= 15.5   50= 17.0   75= 18.5                             11.6  [illegible]
25-34,900       MP  25= 21.3   50= 22.5   75= [illegible]                      [illegible]
35,000+         MP  25= 18.5   50= 22.5   75= 30.0                             2.3  [illegible]
NO RESPONSE                                                                    [illegible]
TOTAL KNOWN     MP  25= 17.0   50= 20.0   75= [illegible]                      [illegible]  100.0
                                                                                  A100
DIMENSION-001  PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: TOTAL KNOWN
UNDER 8,000     MP  25= 2.2    50= [illegible]   75= [illegible]               171  [illegible]
8-10,900        MP  25= [illegible]   50= [illegible]   75= 10.3               94   [illegible]
11-13,900       MP  25= [illegible]   50= [illegible]   75= [illegible]        55   [illegible]
14-16,900       MP  25= [illegible]   50= 14.5   75= [illegible]               55   2710
17-19,900       MP  25= 16.5   50= [illegible]   75= [illegible]               33   2024
20-24,900       MP  25= 19.0   50= [illegible]   75= [illegible]               53   3261
25-34,900       MP  25= 23.0   50= [illegible]   75= [illegible]               51   [illegible]
35,000+         MP  25= 26.7   50= 34.0   75= [illegible]                      10   [illegible]
NO RESPONSE     MP  25= 12.7   50= [illegible]   75= [illegible]               444  [illegible]
TOTAL KNOWN     MP  25= 13.2   50= 17.4   75= 22.1                             491  14807
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*T12 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE                              A101
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: PANEL GROUP 1 -- A & R
DIMENSION-003  EMP + SAL BASE: UNIV - 9 MOS.
                        ----- ----- ----- SALARY (IN THOUSANDS) ----- ----- -----
                        UNDER  8.0-  11.0-  14.0-  17.0-  20.0-  25.0-         NO    TOTAL
INCOME                   8.0   10.9  13.9   16.9   19.9   24.9   34.9  35.0+  RESP.  KNOWN
UNDER 8,000       N        1                                                          1
                  H      100.0                                                      100.0
                  V      100.0                                                       16.7
                  MP   25=  2.0      50=  4.0      75=  6.0
8-10,900          N             3                                                     3
                  H           100.0                                                 100.0
                  V           100.0                                                  50.0
                  MP   25=  8.0      50=  9.5      75= 10.3
11-13,900         N                   1                                               1
                  H                 100.0                                           100.0
                  V                  50.0                                            16.7
                  MP   25= 11.0      50= 12.5      75= 13.3
14-16,900         N                   1                                               1
                  H                 100.0                                           100.0
                  V                  50.0                                            16.7
                  MP   25= 11.0      50= 12.5      75= 13.3
17-19,900         N
                  H
                  V
20-24,900         N
                  H
                  V
25-34,900         N
                  H
                  V
35,000+           N
                  H
                  V
NO RESPONSE       N
                  H
                  V
TOTAL KNOWN       N        1    3     2                                               6
                  H      16.7 50.0  33.3                                            100.0
                  MP   25=  8.5      50= 10.0      75= 11.0
DIMENSION-001  NO PHD                                                                              A102
DIMENSION-002  EMP SPEC: PANEL GROUP 1 -- A & R
DIMENSION-003  EMP + SAL BASE: UNIV - 12 MOS.
UNDER 8,000       N        2                                                   58     2
                  H      100.0                                                      100.0
                  V      100.0                                                 98.3  25.0
                  MP   25=  2.0      50=  4.0      75=  6.0
8-10,900          N             3                                               1     3
                  H           100.0                                                 100.0
                  V           100.0                                             1.7  37.5
                  MP   25=  8.0      50=  9.5      75= 10.3
11-13,900         N                   2                                               2
                  H                 100.0                                           100.0
                  V                  66.7                                            25.0
                  MP   25= 11.0      50= 12.5      75= 13.3
14-16,900         N                   1                                               1
                  H                 100.0                                           100.0
                  V                  33.3                                            12.5
                  MP   25= 11.0      50= 12.5      75= 13.3
17-19,900         N
                  H
                  V
20-24,900         N
                  H
                  V
25-34,900         N
                  H
                  V
35,000+           N
                  H
                  V
NO RESPONSE       N                                         1                  12     1
                  H                                       100.0                     100.0
                  MP   25= 27.5      50= 30.0      75= 32.5
TOTAL KNOWN       N        2    3     3                                        59     8
                  H      25.0 37.5  37.5                                            100.0
                  MP   25=  8.0      50= 10.0      75= 12.0
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A103

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0112 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASES UNIV - 9 MOS.
                          ----- ----- ----- SALARY (IN THOUSANDS) ----- ----- -----
                          UNDER 8.0-  11.0- 14.0- 17.0- 20.0- 25.0-        NO    TOTAL
INCOME                     8.0  10.9  13.9  16.9  19.9  24.9  34.9  35.0+ RESP. KNOWN
UNDER 8,000        N       [illegible]                                            [illegible]
                   H                                                              100.0
                   V                                                              [illegible]
                   MP  25= [illegible].1   50=  4.1    75=  6.2
8-10,900           N       [illegible]                                            308
                   H                                                              [illegible]
                   V                                                              38.9
                   MP  25=  8.4    50=  [illegible].3    75= 10.1
11-13,900          N       [illegible]                                            229
                   H                                                              [illegible]
                   V                                                              29.0
                   MP  25=  [illegible].4    50= 10.8    75= 12.4
14-16,900          N       [illegible]                                            119
                   H                                                              [illegible]
                   V                                                              15.0
                   MP  25= 11.3    50= 12.7    75= 14.0
17-19,900          N       [illegible]                                            40
                   H                                                              100.0
                   V                                                              5.1
                   MP  25= 12.8    50= 14.8    75= 16.3
20-24,900          N       [illegible]                                            21
                   H                                                              100.0
                   V                                                              [illegible]
                   MP  25= 14.4    50= 16.8    75= 17.9
25-34,900          N       [illegible]                                            [illegible]
                   H                                                              100.0
                   V                                                              .[illegible]
                   MP  25= 20.8    50= 23.3    75= 27.5
35,000+            N                                                              [illegible]
                   H                100.0                                         100.0
                   V                                                              .1
                   MP  25= 11.8    50= 12.5    75= 13.3
NO RESPONSE        N       [illegible]                                            36
                   H                                                              100.0
                   V
                   MP  25=  [illegible].8    50= 10.0    75= [illegible].5
TOTAL KNOWN        N       10[illegible]  411  192  61  [illegible]  4  1          791
                   H       13.[illegible]  52.0  24.[illegible]  7.[illegible]  1.[illegible]  .5  .1     100.1
                   MP  25=  8.7    50= 10.1    75= 12.2
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A104

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DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASES: UNIV - 12 MOS.
UNDER 8,000        N       [illegible]                                     2930   120
                   H                                                              100.0
                   V                                                       99.1   14.7
                   MP  25= [illegible].1   50=  4.2    75=  6.3
8-10,900           N       [illegible]                                     83     222
                   H                                                              100.0
                   V                                                       2.7    27.3
                   MP  25=  [illegible].5    50=  [illegible].4    75= 10.2
11-13,900          N       [illegible]                                     32     217
                   H                                                              100.0
                   V                                                       1.0    26.7
                   MP  25= 11.2    50= [illegible].1    75= 13.1
14-16,900          N       [illegible]                                     18     122
                   H                                                              100.0
                   V                                                       .6     15.0
                   MP  25= 13.4    50= [illegible].8    75= [illegible].9
17-19,900          N       [illegible]                                     3      [illegible]
                   H                                                              100.0
                   V                                                       .1     [illegible]
                   MP  25= 15.3    50= [illegible].4    75= [illegible].7
20-24,900          N       [illegible]                                     4      50
                   H                                                              100.0
                   V                                                       .1     6.1
                   MP  25= 16.8    50= 20.2    75= 22.6
25-34,900          N       [illegible]                                     6      20
                   H                                                              100.0
                   V                                                       .2     2.5
                   MP  25= 20.0    50= 23.6    75= 30.0
35,000+            N       [illegible]                                     4      [illegible]
                   H                                                              100.0
                   V                                                       .1     [illegible]
                   MP  25= 22.5    50= 28.3    75= 33.3
NO RESPONSE        N       [illegible]                                     544    44
                   H                                                              100.1
                   MP  25=  [illegible].9    50= 10.7    75= 13.3
TOTAL KNOWN        N       135  256  210  112  47  34  11  1               3080   814
                   H       [illegible]                                            100.1
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                 MP   25=  8.8     50= 11.2     75= 14.0

*T12 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: PRIVATE INDUSTRY
                          ----- ----- ----- SALAR Y (IN THOUS ANDS) ----- ----- -----
                          UNDER  8.0-  11.0-  14.0-  17.0-  20.0-  25.0-          NO   TOTAL
INCOME                      8.0  10.9   13.9   16.9   19.9   24.9   34.9  35.0+ RESP.  KNOWN
UNDER 8,000        N         12     1      1                                     30     14
                   H       85.7   7.1    7.1                                           99.9
                   V       66.7    .4     .1                                   25.9     .3
                   MP   25=  2.3       50=  4.7       75=  7.0
8-10,900           N          2   191      4                                     17    197
                   H        1.0  97.0    2.0                                          100.0
                   V       11.1  73.2     .3                                   11.6    4.1
                   MP   25=  8.7       50=  9.9       75= 10.3
11-13,900          N          1    61    990      4             1                10   1057
                   H         .1   5.8   93.7     .4            .1                     100.1
                   V        5.6  23.4   86.1     .3            .1              12.2   22.1
                   MP   25= 11.6       50= 12.4       75= 13.2
14-16,900          N          2     5    144   1079      1      2                31   1233
                   H         .2    .4   11.7   87.5     .1     .2                     100.1
                   V       11.1   1.9   12.5   83.1     .1     .3              21.1   25.8
                   MP   25= 14.6       50= 15.3       75= 16.2
17-19,900          N                1      9    187    731      1                10    931
                   H               .1    1.0   20.1   78.5     .1                     100.0
                   V               .4     .8   14.4   81.9     .1              12.2   19.5
                   MP   25= 17.1       50= 18.1       75= 19.1
20-24,900          N          1     1      2     23    148    632      1         14    808
                   H         .1    .1     .2    2.8   18.3   78.2     .1               99.8
                   V        5.6    .4     .2    1.8   16.5   84.5     .3          9.5   16.9
                   MP   25= 20.2       50= 21.8       75= 23.4
25-34,900          N                1             5     13    109    294          9    422
                   H               .2           1.2    3.1   25.8   69.7              100.0
                   V               .4            .4    1.5   14.6   86.7          6.1    8.8
                   MP   25= 24.0       50= 27.8       75= 31.4
35,000+            N                              1             3     44     68    2    116
                   H                             .9           2.6   37.9   58.6       100.0
                   V                             .1            .4   13.0  100.0   1.4    2.4
                   MP   25= 30.7       50= 44.5       75= 72.2
NO RESPONSE        N          4    24     74     84     62     32     19      6   116    305
                   H        1.3   7.9   24.3   27.5   20.3   10.5    6.2    2.0         100.0
                   MP   25= 13.0       50= 15.8       75= 19.1
TOTAL KNOWN        N         18   261   1150   1299    895    748    339     68   147   4778
                   H         .4   5.5   24.1   27.2   18.7   15.7    7.1    1.4         100.1
                   MP   25= 13.4       50= 16.2       75= 19.9
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: GOVERNMENT - FEDERAL ETC.
UNDER 8,000        N          1                                                  29      1
                   H      100.0                                                       100.0
                   V      100.0                                                38.7     .3
                   MP   25=  2.0       50=  4.0       75=  6.0
8-10,900           N               73      1      1                              13     75
                   H             97.3    1.3    1.3                                    99.9
                   V             76.0     .2     .1                            17.3    3.2
                   MP   25=  8.8       50=  9.5       75= 10.3
11-13,900          N               22    458                                     11    480
                   H              4.6   95.4                                          100.0
                   V             22.9   88.8                                   14.7   20.7
                   MP   25= 11.6       50= 12.4       75= 13.2
14-16,900          N                1     53    629                              10    683
                   H               .1    7.8   92.1                                   100.0
                   V              1.0   10.3   92.2                            13.3   29.4
                   MP   25= 14.6       50= 15.4       75= 16.2
17-19,900          N                       1     43    446      1      1          3    492
                   H                      .2    8.7   90.7     .2     .2              100.0
                   V                      .2    6.3   93.5     .3     .6          4.0   21.2
                   MP   25= 17.5       50= 18.4       75= 19.2
20-24,900          N                       1      8     31    360                 7    400
                   H                      .3    2.0    7.8   90.0                     100.1
                   V                      .2    1.2    6.5   95.2                 9.3   17.2
                   MP   25= 20.8       50= 22.2       75= 23.6
25-34,900          N                              1            17    167          1    185
                   H                             .5           9.2   90.3              100.0
                   V                             .1           4.5   98.8          1.3    8.0
                   MP   25= 26.7       50= 29.5       75= 32.2
35,000+            N                                                   1      1     1      2
                   H                                                50.0   50.0        100.0
                   V                                                  .6  100.0   1.3     .1
                   MP   25= 30.0       50= 35.0       75= 47.5
NO RESPONSE        N          1     9     27     30     30     15      6           20    118
                   H         .8   7.6   22.9   25.4   25.4   12.7    5.1                99.9
                   MP   25= 13.2       50= 15.2       75= 19.2
TOTAL KNOWN        N          7    96    516    682    475    378    169      1    75   2324
                   H         .3   4.1   22.2   29.3   20.4   16.3    7.3                99.9
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                    MP   25= 13.8     50= 16.4     75= 19.8
#712 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE                                   A10
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: RESEARCH CENTER
                      ----- ----- ----- SALARY (IN THOUS AMTS) ----- ----- -----
INCOME                UNDER 8.0-  11.0- 14.0- 17.0- 20.0- 25.0-              NO    TOTAL
                       8.0  10.9  13.9  16.9  19.9  24.9  34.9  35.0+      RESP.  KNOWN
UNDER 8,000      N      4                                                    95      4
                 H    100.0                                                        100.0
                 V    100.0                                                 83.3     .6
8-10,900         MP   25=  2.0     50=  4.0     75=  6.0
                 N           39   [illegible]                                 7     46
                 H      [illegible]  2.[illegible]                                 100.0
                 V      [illegible]   .[illegible]                           6.1  [illegible]
11-13,900        MP   25=  8.8     50=  9.5     75= 10.3
                 N            7   153                                         1    161
                 H          [illegible]  [illegible]                               100.0
                 V          14.[illegible]  [illegible]                        .9   22.6
14-16,900        MP   25= 11.6     50= 12.4     75= 13.2
                 N            1   [illegible]  169                            2    179
                 H           .[illegible]  [illegible]  94.4                       100.0
                 V          2.1   [illegible]  90.9                          1.8   25.1
17-19,900        MP   25= 14.6     50= 15.4     75= 16.2
                 N                      12  [illegible]                       2    148
                 H                 [illegible]  [illegible]                        100.0
                 V                 [illegible]  [illegible]                  1.8   20.8
20-24,900        MP   25= 17.6     50= 18.4     75= 19.2
                 N               [illegible]  [illegible]  [illegible]  114   4    121
                 H                .[illegible]  [illegible]  [illegible]  93.[illegible]  100.0
                 V               [illegible]  [illegible]  [illegible]  93.4 3.5 [illegible]
25-34,900        MP   25= 20.9     50= 22.2     75= 23.6
                 N                       [illegible]  [illegible]  41          3     50
                 H                      2.[illegible]  [illegible]  [illegible]     100.0
                 V                       [illegible]  6.6  95.3              2.6    7.0
35,000+          MP   25= 25.9     50= 28.9     75= 32.0
                 N                                     2     2                       4
                 H                                  50.0  50.0                   100.0
                 V                                   4.[illegible] 100.0              .6
NO RESPONSE      MP   25= 30.0     50= 35.0     75= 67.5
                 N            2    10     7     4                            20     23
                 H          8.7  43.5  30.4  17.4                                100.0
TOTAL KNOWN      MP   25= 12.1     50= 13.9     75= 16.3
                 N   [illegible]  47   164   186   144   122  [illegible]  [illegible]  114  713
                 H   [illegible]  6.6  23.0  26.1  20.2  17.1  6.0    .3            99.[illegible]
                 MP   25= 13.3     50= 16.3     75= 15.8
DIMENSION-001  NO PHD                                                                                 A108
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: OTHER KNOWN
UNDER 8,000      N     174     5     2                                      168    181
                 H    96.[illegible]  [illegible]  [illegible]                    100.0
                 V    74.5    .5    .2                                      91.1   13.3
8-10,900         MP   25=  [illegible].0     50=  [illegible].1     75=  [illegible].1
                 N     114   671  [illegible]                                59    789
                 H    14.6  85.0    .[illegible]                  .[illegible]    100.0
                 V    22.[illegible]  72.6   .[illegible]                          17.9   27.4
11-13,900        MP   25=  [illegible].4     50=  [illegible].2     75= 10.1
                 N      16   219   574                                            43    809
                 H     [illegible]  2[illegible].[illegible]  71.[illegible]           [illegible]  100.0
                 V     [illegible]  23.3  71.[illegible]                    10.0  13.1   27.0
14-16,900        MP   25= 12.7     50= 11.9     75= 13.0
                 N       2    24   195   294                                     32    519
                 H      .4   [illegible]  [illegible]  [illegible]                      100.0
                 V      .6   [illegible]  24.[illegible]  70.[illegible]              9.7   18.1
17-19,900        MP   25= 12.5     50= 14.4     75= 15.7
                 N             3    19    94    [illegible]                        4    197
                 H           1.5   9.6  48.[illegible]  40.[illegible]                 99.[illegible]
                 V            .3   2.4  23.1  63.[illegible]                     1.0    6.9
20-24,900        MP   25= 14.9     50= 16.4     75= 18.1
                 N    [illegible]  [illegible]  [illegible]  20   39   54                9    124
                 H     .[illegible]   .[illegible]  7.[illegible]  16.[illegible]  31.[illegible]  43.[illegible]     100.0
                 V     .[illegible]   .[illegible]  [illegible]  4.8  31.5  75.0      2.7  [illegible]
25-34,900        MP   25= 17.0     50= 19.4     75= 22.1
                 N                 [illegible]  [illegible]  [illegible]  14   18      9     43
                 H                 4.[illegible]  [illegible]  11.[illegible]  33.[illegible]  40.0   100.0
                 V                       1.0  [illegible]  22.2  78.3      2.7   1.6
35,000+          MP   25= 20.1     50= 23.6     75= 30.0
                 N                                        3     5     9       3     20
                 H             5.0   5.0  10.0           30.0  25.0  45.0          100.0
                 V              .1    .[illegible]   .5            2.8  21.7  90.0    .9     .7
NO RESPONSE      MP   25= 22.5     50= 33.0     75= 63.0
                 N      47    47    46    26     9     3     1     1       218    180
                 H    26.1  26.1  25.6  14.4   5.0   1.7    .6    .6            100.1
TOTAL KNOWN      MP   25=  [illegible].7     50= 10.7     75= 11.7
                 N     302   924   804   416   124    72    23    10       329   2875
                 H    1[illegible].[illegible]  32.1  28.0  1[illegible].[illegible]  [illegible]  2.5   .8    .3   100.0
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                    MP   25= 8.7     50= 11.0     75= 13.7

*T12 SALARY BY TOTAL INCOME BY EMPLOYER,EMPLOYMENT SPECIALTY,DEGREE                A109
DIMENSION-001  NO PHD
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: NO RESPONSE
                          ----- ----- ----- SALARY (IN THOUSANDS) ----- ----- -----
                          UNDER  8.0-  11.0-  14.0-  17.0-  20.0-  25.0-         NO   TOTAL
INCOME                      8.0  10.9   13.9   16.9   19.9   24.9   34.9  35.0+ RESP.  KNOWN
UNDER 8,000          N        1                                                  293      1
                     H    100.0                                                       100.0
                     V    100.0                                                 75.3   33.3
                     MP   25= 7.0      50= 4.0      75= 6.0
8-10,900             N                                                            29
                     V                                                           7.5
11-13,900            N                                                            23
                     V                                                           5.9
14-16,900            N                          1                                 25      1
                     H                      100.0                                     100.0
                     V                      100.0                                6.4   33.3
                     MP   25= 14.8     50= 15.2     75= 16.3
17-19,900            N                                                            10
                     V                                                           2.6
20-24,900            N                                        1                    6      1
                     H                                    100.0                       100.0
                     V                                    100.0                  1.5   33.3
                     MP   25= 21.3     50= 22.5     75= 23.8
25-34,900            N                                                             3
                     V                                                            .8
35,000+              N
                     V
NO RESPONSE          N                                                          1634
TOTAL KNOWN          N        1                   1           1                  389      3
                     H     33.3                33.3        33.3                        99.9
                     MP   25= 6.0      50= 15.5     75= 21.3
DIMENSION-001  NO PHD                                                              A110
DIMENSION-002  EMP SPEC: TOTAL ALL PANEL GROUPS
DIMENSION-003  EMP + SAL BASE: TOTAL KNOWN
UNDER 8,000          N      577    13      3                                    3260    593
                     H     97.3   2.2     .5                                          100.0
                     V     74.5    .7     .1                                    87.0    5.1
                     MP   25= 2.1      50= 4.1      75= 6.2
8-10,900             N      178  1441      8      3      1                       179   1631
                     H     10.9  88.4     .5     .2     .1                            100.0
                     V     23.0  72.2     .3     .1     .1                       4.8   13.1
                     MP   25= 8.5      50= 9.3      75= 10.2
11-13,900            N       12   469   2456      4      1      1            1   105   2944
                     H       .4  15.9   83.4     .1                                   99.9
                     V      1.6  23.5   80.1     .1            .1          1.2   2.8   23.9
                     MP   25= 11.3     50= 12.2     75= 13.1
14-16,900            N        3    60    501   2286      1      2                 93   2853
                     H       .2   2.1   17.5   80.1            .1                     100.0
                     V       .4   3.0   16.5   82.9     .1     .1                2.5   23.3
                     MP   25= 14.2     50= 15.1     75= 16.1
17-19,900            N              6     51    375   1430      2      1          32   1865
                     H             .3    2.7   20.1   76.7     .1     .1              100.0
                     V             .3    1.7   13.0   84.2     .1     .2           .9   15.2
                     MP   25= 17.1     50= 18.1     75= 19.0
20-24,900            N        2     4     20     73    242   1187      1          38   1529
                     H       .1    .3    1.3    4.8   15.8   77.6     .1              100.0
                     V       .2    .2     .8    2.6   14.3   87.4     .2         1.0   12.5
                     MP   25= 20.2     50= 21.8     75= 23.4
25-34,900            N        1           3     11     23    160    530           28    728
                     H       .1          .4    1.5    3.2   22.0   72.8               100.0
                     V       .1          .1     .4    1.4   11.8   90.3           .7    5.9
                     MP   25= 24.5     50= 28.1     75= 31.6
35,000+              N        1           2      4             6     55     81    10    149
                     H       .7         1.3    2.7           4.0   36.9   54.4        100.0
                     V       .1          .1     .1            .4    9.4   98.8    .3    1.2
                     MP   25= 29.4     50= 30.2     75= [illegible]
NO RESPONSE          N       60   124    175    156    106     51     27      7   934    706
                     H      8.5  17.6   24.8   22.1   15.0    7.2    3.8    1.0        100.0
                     MP   25= 10.8     50= 13.9     75= 17.4
TOTAL KNOWN          N      775  1995   3044   2756   1690   1358    587     81  3743  12296
                     H      6.3  16.2   24.8   22.4   13.8   11.0    4.8     .7        100.0
                     MP   25= 11.3     50= 14.4     75= 18.2
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*T13 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 1 - A & B

AGE in 1970		U.S. BIRTH -----			NONUS BIRTH -----			N.A. BIRTH -----			ALL	ALL	ALL	ALL	ALL	ALL	
		U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	N.A. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	28		1	3	7		3			29	10	3	34	7	1	42
	%	66.7		2.4	7.1	16.7		7.1			69.0	23.8	7.1	81.0	16.7	2.4	
30-34	N	68			2	14					68	16		70	14		84
	%	81.0			2.4	16.7					81.0	19.0		83.3	16.7		
35-39	N	35			4	14		3			35	18	3	42	14		56
	%	62.5			7.1	25.0		5.4			62.5	32.1	5.4	75.0	25.0		
40-44	N	22			4	6		2			22	10	2	28	6		34
	%	64.7			11.8	17.6		5.9			64.7	29.4	5.9	82.4	17.6		
45-49	N	13			1	1					13	2		14	1		15
	%	86.7			6.7	6.7					86.7	13.3		93.3	6.7		
50-54	N	6			2	2		1			6	4	1	9	2		11
	%	54.5			18.2	18.2		9.1			54.5	36.4	9.1	81.8	18.2		
55-59	N	5			1	1					5	2		6	1		7
	%	71.4			14.3	14.3					71.4	28.6		85.7	14.3		
60-64	N	1			1						1	1		2			2
	%	50.0			50.0						50.0	50.0		100.0			
65-69	N				4							4		4			4
	%				100.0							100.0		100.0			
70 + OVER	N																
	%																
TOTAL KNOWN	N	178		1	22	45		9			179	67	9	209	45	1	255
	%	69.8		.4	8.6	17.6		3.5			70.2	26.3	3.5	82.0	17.6	.4	
NO RESPONSE	N	1					1				1	1		1		1	2
	%	50.0					50.0				50.0	50.0		50.0		50.0	
	VP 50=	34.0		27.0	42.0	35.0		37.0			33.9	36.6	37.0	34.6	35.0	27.0	34.6

*113 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 PE
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 2 - A B E

AGE		U.S. BIRTH U.S. CITIZ	U.S. BIRTH NON-CITIZ	U.S. BIRTH CITIZ UNK	NONUS BIRTH U.S. CITIZ	NONUS BIRTH NON-CITIZ	NONUS BIRTH CITIZ UNK	N.R. BIRTH U.S. CITIZ	N.R. BIRTH NON-CITIZ	N.R. BIRTH CITIZ UNK	ALL U.S. BIRTH	ALL NONUS BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N	1				1					1	1		1	1		2
	%	50.0				50.0					50.0	50.0		50.0	50.0		
25-29	N	123			2	20		7		2	123	22	9	132	20	2	154
	%	79.9			1.3	13.0		4.5		1.3	79.9	14.3	5.8	85.7	13.0	1.3	
30-34	N	283		2	19	60	2	3		1	285	81	4	305	60	5	370
	%	76.5		.5	5.1	16.2	.5	.8		.3	77.0	21.9	1.1	82.4	16.2	1.4	
35-39	N	123		1	22	35		6	1		124	57	7	151	36	1	188
	%	65.4		.5	11.7	18.6		3.2	.5		66.0	30.3	3.7	80.3	19.1	.5	
40-44	N	113		2	16	14		3			115	30	3	132	14	2	148
	%	76.4		1.4	10.8	9.5		2.0			77.7	20.3	2.0	89.2	9.5	1.4	
45-49	N	70		1	29	11		3			71	40	3	102	11	1	114
	%	61.4		.9	25.4	9.6		2.6			62.3	35.1	2.6	89.5	9.6	.9	
50-54	N	40		1	9	4	1	1			41	14	1	50	4	2	56
	%	71.4		1.8	16.1	7.1	1.8	1.8			73.2	25.0	1.8	89.3	7.1	3.6	
55-59	N	16		1	7			1			17	7	1	24		1	25
	%	64.0		4.0	28.0			4.0			68.0	28.0	4.0	96.0		4.0	
60-64	N	20			3	2					20	5		23	2		25
	%	80.0			12.0	8.0					80.0	20.0		92.0	8.0		
65-69	N	11			3						11	3		14			14
	%	78.6			21.4						78.6	21.4		100.0			
70 + OVER	N	5			1						5	1		6			6
	%	83.3			16.7						83.3	16.7		100.0			
TOTAL KNOWN	N	805		8	111	147	3	24	1	3	813	261	28	940	148	14	1102
	%	73.0		.7	10.1	13.3	.3	2.2	.1	.3	73.8	23.7	2.5	85.3	13.4	1.3	
NO RESPONSE	N																
	%																
	VP 50=	36.4		42.0	43.4	31.9	53.5	56.2	37.0	28.3	36.5	38.8	35.2	39.6	31.9	36.5	35.2

*T13 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE A113

DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 3 - 5 P

AGE		U.S. BIRTH U.S. CITIZ	U.S. BIRTH NON-CITIZ	U.S. BIRTH CITIZ UNK	NONUS BIRTH U.S. CITIZ	NONUS BIRTH NON-CITIZ	NONUS BIRTH CITIZ UNK	N.R. BIRTH U.S. CITIZ	N.R. BIRTH NON-CITIZ	N.R. BIRTH CITIZ UNK	ALL U.S. BIRTH	ALL NONUS BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	196		2	15	43		8			198	58	8	219	43	2	264
	%	74.2		.8	5.7	16.3		3.0			75.0	22.0	3.0	83.0	16.3	.8	
30-34	N	345		3	31	100	3	8			348	134	8	384	100	6	490
	%	70.4		.6	6.3	20.4	.6	1.6			71.0	27.3	1.6	78.4	20.4	1.2	
35-39	N	203			24	68	4	3			203	96	3	230	68	4	302
	%	67.2			7.9	22.5	1.3	1.0			67.2	31.8	1.0	76.2	22.5	1.3	
40-44	N	108		2	28	45	1	4			110	74	4	140	45	3	188
	%	57.4		1.1	14.9	23.9	.5	2.1			58.5	39.4	2.1	74.5	23.9	1.6	
45-49	N	70			24	9	2	2			70	35	2	96	9	2	107
	%	65.4			22.4	8.4	1.9	1.9			65.4	32.7	1.9	89.7	8.4	1.9	
50-54	N	27			7			4			27	7	4	38			38
	%	71.1			18.4			10.5			71.1	18.4	10.5	100.0			
55-59	N	17			6			2			17	6	2	25			25
	%	68.0			24.0			8.0			68.0	24.0	8.0	100.0			
60-64	N	8			3						8	3		11			11
	%	72.7			27.3						72.7	27.3		100.0			
65-69	N	7			4			1			7	4	1	12			12
	%	58.3			33.3			8.3			58.3	33.3	8.3	100.0			
70 + OVER	N	3									3			3			3
	%	100.0									100.0			100.0			
TOTAL KNOWN	N	984		7	142	265	10	32			991	417	32	1158	265	17	1440
	%	68.3		.5	9.9	18.4	.7	2.2			68.8	29.0	2.2	80.4	18.4	1.2	
NO RESPONSE	N	1			1						1	1		2			2
	%	50.0			50.0						50.0	50.0		100.0			
	VP 50=	33.8		32.0	34.7	34.0	37.0	34.5			33.8	35.4	34.5	34.2	34.0	35.1	34.2

0713 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC1 PANEL GROUP 4 - N P

		U.S.	BIRTH	-----	NONUS	BIRTH	-----	N.R.	BIRTH	-----	ALL	ALL	ALL	ALL	ALL	ALL	
		U.S.	NON-	CITIZ	U.S.	NON-	CITIZ	U.S.	NON-	CITIZ	U.S.	NONUS	N.R.	U.S.	NONUS	UNK.	GRAND
AGE		CITIZ	CITIZ	UNK	CITIZ	CITIZ	UNK	CITIZ	CITIZ	UNK	BIRTH	BIRTH	BIRTH	CITIZ	CITIZ	CITIZ	TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	191		2	7	20	1	2			193	28	2	200	20	3	223
	%	85.7		.9	3.1	9.0	.4	.9			86.5	12.6	.9	89.7	9.0	1.3	
30-34	N	353		3	24	79	3	9	1		356	106	10	386	80	6	472
	%	74.8		.6	5.1	16.7	.6	1.9	.2		75.4	22.5	2.1	81.8	16.9	1.3	
35-39	N	231		1	28	63	1	12	1		232	92	13	271	64	2	337
	%	68.5		.3	8.3	18.7	.3	3.6	.3		68.8	27.3	[illegible]	80.4	19.0	[illegible]	
40-44	N	235		2	34	45		8			237	79	[illegible]	277	45	2	324
	%	72.5		.6	10.5	13.9		2.5			73.1	24.4	[illegible]	85.5	13.9	.6	
45-49	N	185		4	32	11	3	4	1		189	46	5	221	12	7	240
	%	77.1		1.7	13.3	4.6	1.3	1.7	.4		78.8	19.2	2.1	92.1	5.0	2.9	
50-54	N	92			21	5		5			92	26	5	118	5		123
	%	74.8			17.1	4.1		4.1			74.8	21.1	4.1	95.9	4.1		
55-59	N	39		1	11	1		1			40	12	1	51	1	1	53
	%	73.6		1.9	20.8	1.9		1.9			75.5	22.6	1.9	96.2	1.9	1.9	
60-64	N	23			7	1					23	8		30	1		31
	%	74.2			22.6	3.2					74.2	25.8		96.8	3.2		
65-69	N	9			5			1			9	5	1	15			15
	%	60.0			33.3			6.7			60.0	33.3	6.7	100.0			
70 + OVER	N	3			3						3	3		6			6
	%	50.0			50.0						50.0	50.0		100.0			
TOTAL KNOWN	N	1361		13	172	225	8	42	3		1374	405	45	1575	228	21	1824
	%	74.6		.7	9.4	12.3	.4	2.3	.2		75.3	22.2	2.5	86.3	12.5	1.2	
NO RESPONSE	N																
	%																
	VP 50=	37.5		40.0	43.5	35.6	34.5	38.7	37.0		37.5	38.2	38.5	38.2	35.6	38.1	37.7

300

*T13 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPECL PANEL GROUP 13 - F

AGE		U.S. BIRTH			NONUS BIRTH			N.R. BIRTH			ALL U.S. BIRTH	ALL NONUS BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
		U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK							
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	42		2		6		1		1	44	6	2	43	6	3	52
	%	80.8		3.8		11.5		1.9		1.9	84.6	11.5	3.8	82.7	11.5	5.8	
30-34	N	112		1	13	24	1	1		1	113	38	2	126	24	3	153
	%	73.2		.7	8.5	15.7	.7	.7		.7	73.9	24.8	1.3	82.4	15.7	2.0	
35-39	N	74		1	14	23		2			75	37	2	90	23	1	114
	%	64.9		.9	12.3	20.2		1.8			65.8	32.5	1.8	78.9	20.2	.9	
40-44	N	62			18	10		2			62	28	2	82	10		92
	%	67.4			19.6	10.9		2.2			67.4	30.4	2.2	89.1	10.9		
45-49	N	56		1	17	4		2			57	21	2	75	4	1	80
	%	70.0		1.3	21.3	5.0		2.5			71.3	26.3	2.5	93.8	5.0	1.3	
50-54	N	25			17	3		2			25	20	2	44	3		47
	%	53.2			36.2	6.4		4.3			53.2	42.6	4.3	93.6	6.4		
55-59	N	9			10						9	10		19			19
	%	47.4			52.6						47.4	52.6		100.0			
60-64	N	4			5						4	5		9			9
	%	44.4			55.6						44.4	55.6		100.0			
65-69	N	6			1						6	1		7			7
	%	85.7			14.3						85.7	14.3		100.0			
70 + OVER	N	2			1						2	1		3			3
	%	66.7			33.3						66.7	33.3		100.0			
TOTAL KNOWN	N	392		5	96	70	1	10		2	397	167	12	498	70	8	576
	%	68.1		.9	16.7	12.2	.2	1.7		.3	68.9	29.0	2.1	86.5	12.2	1.4	
NO RESPONSE	N	2				1					2	1		2	1		3
	%	66.7				33.3					66.7	33.3		66.7	33.3		
	[illegible]	37.3		32.0	43.4	35.6	32.0	42.0		29.5	37.3	39.9	30.5	36.9	35.0	31.2	38.1

0113 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE A116
DIMENSION-001 EL
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 59 - P

AGE		U.S. BIRTH U.S. CITIZ	U.S. BIRTH NON-CITIZ	U.S. BIRTH CITIZ UNK	NONUS BIRTH U.S. CITIZ	NONUS BIRTH NON-CITIZ	NONUS BIRTH CITIZ UNK	UNK. BIRTH U.S. CITIZ	UNK. BIRTH NON-CITIZ	UNK. BIRTH CITIZ UNK	ALL U.S. BIRTH	ALL NONUS BIRTH	ALL UNK. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N %																
20-24	N %					2 100.0						2 100.0			2 100.0		2
25-29	N %	54 83.1			2 3.1	6 9.2		2 3.1		1 1.5	54 83.1	8 12.3	3 4.6	58 89.2	6 9.2	1 1.5	65
30-34	N %	126 75.9		1 .6	7 4.2	28 16.9	1 .6	3 1.8			127 76.5	36 21.7	3 1.8	136 81.9	28 16.9	2 1.2	166
35-39	N %	83 64.8		1 .8	13 10.2	28 21.9		3 2.3			84 65.6	41 32.0	3 2.3	99 77.3	28 21.9	1 .8	128
40-44	N %	56 57.1	1 1.0		31 31.6	9 9.2		1 1.0			57 58.2	40 40.8	1 1.0	88 89.8	10 10.2		98
45-49	N %	31 64.6			10 20.8	4 8.3		3 6.3			31 64.6	14 29.2	3 6.3	44 91.7	4 8.3		48
50-54	N %	13 72.2			4 22.2			1 5.6			13 72.2	4 22.2	1 5.6	18 100.0			18
55-59	N %	7 70.0			2 20.0			1 10.0			7 70.0	2 20.0	1 10.0	10 100.0			10
60-64	N %	4 80.0			1 20.0						4 80.0	1 20.0		5 100.0			5
65-69	N %				2 100.0							2 100.0		2 100.0			2
70 + OVER	N %																
TOTAL KNOWN	N %	374 69.0	1 .2	2 .4	72 13.3	77 14.2	1 .2	14 2.6		1 .2	377 69.6	150 27.7	15 2.8	460 84.9	78 14.4	4 .7	542
NO RESPONSE	N %																
	MD=	34.9	42.0	36.5	41.0	36.9	32.0	37.0		27.0	34.9	38.0	37.0	36.1	35.0	32.0	36.0

*115 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE A117
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC, PANEL GROUP 3 - P & P

AGE		U.S. BIRTH			NONUS BIRTH			N.R. BIRTH			ALL	ALL	ALL	ALL	ALL	ALL	
		U.S. CITIZ	NON- CITIZ	CITIZ UNK	U.S. CITIZ	NON- CITIZ	CITIZ UNK	U.S. CITIZ	NON- CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	N.R. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N					2						2			2		2
	%					100.0						100.0			100.0		
25-29	N	96		2	2	12		3		2	98	14	5	101	12	4	117
	%	82.1		1.7	1.7	10.3		2.6		1.7	83.8	12.0	4.3	86.3	10.3	3.4	
30-34	N	238		2	20	52	2	4		1	240	74	5	262	52	5	319
	%	74.6		.6	6.3	16.3	.6	1.3		.3	75.2	23.2	1.6	82.1	16.3	1.6	
35-39	N	157		2	27	51		5			159	78	5	189	51	2	242
	%	64.9		.8	11.2	21.1		2.1			65.7	32.2	2.1	78.1	21.1	.8	
40-44	N	118	1		49	19		3			119	68	3	170	20		190
	%	62.1	.5		25.8	10.0		1.6			62.6	35.8	1.6	89.5	10.5		
45-49	N	87		1	27	8		5			88	35	5	119	8	1	128
	%	68.0		.8	21.1	6.3		3.9			68.8	27.3	3.9	93.0	6.3	.8	
50-54	N	38			21	3		3			38	24	3	62	3		65
	%	58.5			32.3	4.6		4.6			58.5	36.9	4.6	95.4	4.6		
55-59	N	16			12			1			16	12	1	29			29
	%	55.2			41.4			3.4			55.2	41.4	3.4	100.0			
60-64	N	8			6						8	6		14			14
	%	57.1			42.9						57.1	42.9		100.0			
65-69	N	6			3						6	3		9			9
	%	66.7			33.3						66.7	33.3		100.0			
70 + OVER	N	2			1						2	1		3			3
	%	66.7			33.3						66.7	33.3		100.0			
TOTAL KNOWN	N	766	1	7	168	147	2	24		3	774	317	27	958	148	12	1118
	%	68.5	.1	.6	15.0	13.1	.2	2.1		.3	69.2	28.4	2.4	85.7	13.2	1.1	
NO RESPONSE	N	2				1					2	1		2	1		3
	%	66.7				33.3					66.7	33.3		66.7	33.3		
	MD AGE	34.1	42.0	35.5	41.1	39.2	32.0	39.5		28.3	34.0	39.9	38.0	37.4	38.5	31.5	37.0

0713 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 6 - C H

AGE		U.S. BIRTH			NON-US BIRTH			N.R. BIRTH			ALL	ALL	ALL	ALL	ALL	ALL	
		U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	N.R. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N					1						1			1		1
	%					100.0						100.0			100.0		
25-29	N	416		10	14	68	1	6		1	426	83	7	436	68	12	516
	%	80.6		1.9	2.7	13.2	.2	1.2		.2	82.6	16.1	1.4	84.5	13.2	2.3	
30-34	N	947		14	63	206	4	24	2	2	961	273	28	1034	208	20	1262
	%	75.0		1.1	5.0	16.3	.3	1.9	.2	.2	76.1	21.6	2.2	81.9	16.5	1.6	
35-39	N	642	1	5	81	159	6	29	1	1	648	246	31	752	161	12	925
	%	69.4	.1	.5	8.8	17.2	.6	3.1	.1	.1	70.1	26.6	3.4	81.3	17.4	1.3	
40-44	N	462			107	88		13	1		462	195	14	582	89		671
	%	68.9			15.9	13.1		1.9	.1		68.9	29.1	2.1	86.7	13.3		
45-49	N	337		3	75	29	3	12			340	107	12	424	29	6	459
	%	73.4		.7	16.3	6.3	.7	2.6			74.1	23.3	2.6	92.4	6.3	1.3	
50-54	N	131			27	7	1	8			131	35	8	166	7	1	174
	%	75.3			15.5	4.0	.6	4.6			75.3	20.1	4.6	95.4	4.0	.6	
55-59	N	73		3	23	4		5			76	27	5	101	4	3	108
	%	67.6		2.8	21.3	3.7		4.6			70.4	25.0	4.6	93.5	3.7	2.8	
60-64	N	37			27	1		1			37	28	1	65	1		66
	%	56.1			40.9	1.5		1.5			56.1	42.4	1.5	98.5	1.5		
65-69	N	23			17	1		2			23	18	2	42	1		43
	%	53.5			39.5	2.3		4.7			53.5	41.9	4.7	97.7	2.3		
70 + OVER	N	6			3			1			6	3	1	10			10
	%	60.0			30.0			10.0			60.0	30.0	10.0	100.0			
TOTAL KNOWN	N	3074	1	35	437	564	15	101	4	4	3110	1016	109	3612	569	54	4235
	%	72.6		.8	10.3	13.3	.4	2.4	.1	.1	73.4	24.0	2.6	85.3	13.4	1.3	
NO RESPONSE	N	1		1	2			1			2	2	1	4		1	5
	%	20.0		20.0	40.0			20.0			40.0	40.0	20.0	80.0		20.0	
	VP 50-	33.9	37.0	32.2	42.1	36.7	36.6	30.0	36.5	32.0	35.8	37.6	37.6	36.7	36.7	33.3	36.3

0713 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE, EMPLOYMENT SPECIALTY, DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 7 - S L P

AGE		U.S. BIRTH U.S. CITIZ	U.S. BIRTH NON-CITIZ	U.S. BIRTH CITIZ UNK	NONUS BIRTH U.S. CITIZ	NONUS BIRTH NON-CITIZ	NONUS BIRTH CITIZ UNK	N.R. BIRTH U.S. CITIZ	N.R. BIRTH NON-CITIZ	N.R. BIRTH CITIZ UNK	ALL U.S. BIRTH	ALL NONUS BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	69		5	2	7		3			74	9	3	74	7	5	86
	%	80.2		5.8	2.3	8.1		3.5			86.0	10.5	3.5	86.0	8.1	5.8	
30-34	N	152		2	8	29	1	3			154	38	3	163	29	3	195
	%	77.9		1.0	4.1	14.9	.5	1.5			79.0	19.5	1.5	83.6	14.9	1.5	
35-39	N	102		1	10	20	1				103	31		112	20	2	134
	%	76.1		.7	7.5	14.9	.7				76.9	23.1		83.6	14.9	1.5	
40-44	N	84	1	2	18	7	1	6			87	26	6	108	8	3	119
	%	70.6	.8	1.7	15.1	5.9	.8	5.0			73.1	21.8	5.0	90.8	6.7	2.5	
45-49	N	58	1	2	13	7					61	20		71	8	2	81
	%	71.6	1.2	2.5	16.0	8.6					75.3	24.7		87.7	9.9	2.5	
50-54	N	42			7	2		3			42	9	3	52	2		54
	%	77.8			13.0	3.7		5.6			77.8	16.7	5.6	96.3	3.7		
55-59	N	28			6						28	6		34			34
	%	82.4			17.6						82.4	17.6		100.0			
60-64	N	8			2						8	2		10			10
	%	80.0			20.0						80.0	20.0		100.0			
65-69	N	5			2						5	2		7			7
	%	71.4			28.6						71.4	28.6		100.0			
70 + OVER	N	3				1					3	1		3	1		4
	%	75.0				25.0					75.0	25.0		75.0	25.0		
TOTAL KNOWN	N	551	2	12	68	73	3	15			565	144	15	634	75	15	724
	%	76.1	.3	1.7	9.4	10.1	.4	2.1			78.0	19.9	2.1	87.6	10.4	2.1	
NO RESPONSE	N																
	%																
	MD 50=	37.2	44.5	32.0	43.4	34.6	37.0	40.0			37.1	38.5	40.0	38.1	34.9	33.7	37.5

A120

A113 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 8 - BIO

AGE		U.S. BIRTH ----- U.S. CITIZ	NON-CITIZ	CITIZ UNK	NONUS BIRTH ----- U.S. CITIZ	NON-CITIZ	CITIZ UNK	N.R. BIRTH ----- U.S. CITIZ	NON-CITIZ	CITIZ UNK	ALL U.S. BIRTH	ALL NONUS BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	32			3	4					32	7		35	4		39
	%	82.1			7.7	10.3					82.1	17.9		89.7	10.3		
30-34	N	57			2	9		1			57	11	1	60	9		69
	%	82.6			2.9	13.0		1.4			82.6	15.9	1.4	87.0	13.0		
35-39	N	48			3	4		1			48	7	1	52	4		56
	%	85.7			5.4	7.1		1.8			85.7	12.5	1.8	92.9	7.1		
40-44	N	17			4	7					17	11		21	7		28
	%	60.7			14.3	25.0					60.7	39.3		75.0	25.0		
45-49	N	27		2	6	1					29	7		33	1	2	36
	%	75.0		5.6	16.7	2.8					80.6	19.4		91.7	2.8	5.6	
50-54	N	18			6	2		1			18	8	1	25	2		27
	%	66.7			22.2	7.4		3.7			66.7	29.6	3.7	92.6	7.4		
55-59	N	6			4					1	6	4	1	10		1	11
	%	54.5			36.4					9.1	54.5	36.4	9.1	90.9		9.1	
60-64	N	6									6			6			6
	%	100.0									100.0			100.0			
65-69	N	1			1						1	1		2			2
	%	50.0			50.0						50.0	50.0		100.0			
70 + OVER	N	1			2						1	2		3			3
	%	33.3			66.7						33.3	66.7		100.0			
TOTAL KNOWN	N	213		2	31	27		3		1	215	58	4	247	27	3	277
	%	76.9		.7	11.2	9.7		1.1		.4	77.6	20.9	1.4	89.2	9.7	1.1	
NO RESPONSE	N																
	%																
	YP 50=	36.3		47.0	47.4	35.1		37.0		57.0	36.4	41.5	44.5	37.2	35.1	48.5	37.2

0714 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPECL PANEL GROUP 9 - OPTICS

AGE		U.S. BIRTH ———			NONUS BIRTH ———			U.N. BIRTH ———			ALL	ALL	ALL	ALL	ALL	ALL	
		U.S. CITIZ	NON- CITIZ	CITIZ UNK	U.S. CITIZ	NON- CITIZ	CITIZ UNK	U.S. CITIZ	NON- CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	U.N. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	69			4	10	2	3			69	16	3	76	10	2	88
	%	78.4			4.5	11.4	2.3	3.4			78.4	18.2	3.4	86.4	11.4	2.3	
30-34	N	224		4	5	36	1	6		1	228	42	7	235	36	6	277
	%	80.9		1.4	1.8	13.0	.4	2.2		.4	82.3	15.2	2.5	84.8	13.0	2.2	
35-39	N	155			25	32	2	7			155	59	7	187	32	2	221
	%	70.1			11.3	14.5	.9	3.2			70.1	26.7	3.2	84.6	14.5	.9	
40-44	N	115		3	18	17		6		1	118	35	7	139	17	4	160
	%	71.9		1.9	11.3	10.6		3.8		.6	73.8	21.9	4.4	86.9	10.6	2.5	
45-49	N	108			27	7		2			108	34	2	137	7		144
	%	75.0			18.8	4.9		1.4			75.0	23.6	1.4	95.1	4.9		
50-54	N	58			13	5		5			58	18	5	76	5		81
	%	71.6			16.0	6.2		6.2			71.6	22.2	6.2	93.8	6.2		
55-59	N	44		1	13	1					45	14		57	1	1	59
	%	74.6		1.7	22.0	1.7					76.3	23.7		96.6	1.7	1.7	
60-64	N	30		1	10	1		3			31	11	3	43	1	1	45
	%	66.7		2.2	22.2	2.2		6.7			68.9	24.4	6.7	95.6	2.2	2.2	
65-69	N	15			4	1	1	3			15	6	3	22	1	1	24
	%	62.5			16.7	4.2	4.2	12.5			62.5	25.0	12.5	91.7	4.2	4.2	
70 + OVER	N	5			4	1		1			5	5	1	10	1		11
	%	45.5			36.4	9.1		9.1			45.5	45.5	9.1	90.9	9.1		
TOTAL KNOWN	N	823		9	123	111	6	36		2	832	240	38	982	111	17	1110
	%	74.1		.8	11.1	10.0	.5	3.2		.2	75.0	21.6	3.4	88.5	10.0	1.5	
NO RESPONSE	N	1									1			1			1
	%	100.0									100.0			100.0			
	MD 50=	38.3		48.3	46.3	36.8	36.5	41.2		37.8	38.3	38.6	45.8	39.3	36.8	35.8	38.8

*T13 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE A122

DIMENSION-001 81
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 10 - ACOUSTICS

AGE		U.S. BIRTH ------			NONUS BIRTH ------			N.R. BIRTH ------			ALL	ALL	ALL	ALL	ALL	ALL	
		U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	N.R. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	25						1			25		1	26			26
	%	96.2						3.8			96.2		3.8	100.0			
30-34	N	55		1	3	11		2			56	14	2	60	11	1	72
	%	76.4		1.4	4.2	15.3		2.8			77.8	19.4	2.8	83.3	15.3	1.4	
35-39	N	44		1	3	5		6			45	8	6	53	5	1	59
	%	74.6		1.7	5.1	8.5		10.2			76.3	13.6	10.2	89.8	8.5	1.7	
40-44	N	34			6	7		2			34	13	2	42	7		49
	%	69.4			12.2	14.3		4.1			69.4	26.5	4.1	85.7	14.3		
45-49	N	33			7	1					33	8		40	1		41
	%	80.5			17.1	2.4					80.5	19.5		97.6	2.4		
50-54	N	21			6			2			21	6	2	29			29
	%	72.4			20.7			6.9			72.4	20.7	6.9	100.0			
55-59	N	18			2						18	2		20			20
	%	90.0			10.0						90.0	10.0		100.0			
60-64	N	12			3						12	3		15			15
	%	80.0			20.0						80.0	20.0		100.0			
65-69	N	15			1						15	1		16			16
	%	93.8			6.3						93.8	6.3		100.0			
70 + OVER	N	4			1						4	1		5			5
	%	80.0			20.0						80.0	20.0		100.0			
TOTAL KNOWN	N	261		2	32	24		13			263	56	13	306	24	2	332
	%	78.6		.6	9.6	7.2		3.9			79.2	16.9	3.9	92.2	7.2	.6	
NO RESPONSE	N																
	%																
	VP 50=	40.5		34.5	47.4	35.5		37.4			40.3	41.8	37.4	41.2	35.5	34.5	40.4

4713 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUPS 11-15 - ASTRONOMY

AGE		U.S. BIRTH U.S. CITIZ	U.S. BIRTH NON-CITIZ	U.S. BIRTH CITIZ UNK	NON-US BIRTH U.S. CITIZ	NON-US BIRTH NON-CITIZ	NON-US BIRTH CITIZ UNK	N.R. BIRTH U.S. CITIZ	N.R. BIRTH NON-CITIZ	N.R. BIRTH CITIZ UNK	ALL U.S. BIRTH	ALL NON-US BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NON-US CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	94		2	3	9		1			96	12	1	98	9	2	109
	%	86.2		1.8	2.8	8.3		.9			88.1	11.0	.9	89.9	8.3	1.8	
30-34	N	165		1	7	25		5			166	32	5	177	25	1	203
	%	81.3		.5	3.4	12.3		2.5			81.8	15.8	2.5	87.2	12.3	.5	
35-39	N	74			14	15	1	3			74	30	3	91	15	1	107
	%	69.2			13.1	14.0	.9	2.8			69.2	28.0	2.8	85.0	14.0	.9	
40-44	N	60			10	11					60	21		70	11		81
	%	74.1			12.3	13.6					74.1	25.9		86.4	13.6		
45-49	N	31			12	3	2				31	17		43	3	2	48
	%	64.6			25.0	6.3	4.2				64.6	35.4		89.6	6.3	4.2	
50-54	N	21			4	3		2			21	7	2	27	3		30
	%	70.0			13.3	10.0		6.7			70.0	23.3	6.7	90.0	10.0		
55-59	N	13			7	1					13	8		20	1		21
	%	61.9			33.3	4.8					61.9	38.1		95.2	4.8		
60-64	N	18			5	2					18	7		23	2		25
	%	72.0			20.0	8.0					72.0	28.0		92.0	8.0		
65-69	N	8			3			2			8	3	2	13			13
	%	61.5			23.1			15.4			61.5	23.1	15.4	100.0			
70 & OVER	N	3			1	1	1				3	3		4	1	1	6
	%	50.0			16.7	16.7	16.7				50.0	50.0		66.7	16.7	16.7	
TOTAL KNOWN	N	487		3	66	70	4	13			490	140	13	566	70	7	643
	%	75.7		.5	10.3	10.9	.6	2.0			76.2	21.8	2.0	88.0	10.9	1.1	
NO RESPONSE	N	1									1			1			1
	%	100.0									100.0			100.0			
	MP 50=	36.0		28.3	44.0	34.8	47.0	35.5			36.0	38.6	35.3	36.9	34.8	37.0	36.9

*F13 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 OT
DIMENSION-002 PHD
DIMENSION-003 EMP SPEC: PANEL GROUP 18 - MISC

AGE		U.S. BIRTH ----- U.S. CITIZ	NON-CITIZ	CITIZ UNK	NONUS BIRTH ----- U.S. CITIZ	NON-CITIZ	CITIZ UNK	N.R. BIRTH ----- U.S. CITIZ	NON-CITIZ	CITIZ UNK	ALL U.S. BIRTH	ALL NONUS BIRTH	ALL N.R. BIRTH	ALL U.S. CITIZ	ALL NONUS CITIZ	ALL UNK. CITIZ	GRAND TOTAL
UNDER 20	N																
	%																
20-24	N																
	%																
25-29	N	197		2	9	18	1	3	1	1	199	28	5	209	19	4	232
	%	84.9		.9	3.9	7.8	.4	1.3	.4	.4	85.8	12.1	2.2	90.1	8.2	1.7	
30-34	N	611	1	6	20	66		18	1	1	618	86	20	649	68	7	724
	%	84.4	.1	.8	2.8	9.1		2.5	.1	.1	85.4	11.9	2.8	89.6	9.4	1.0	
35-39	N	476		6	34	64		13			482	98	13	523	64	6	593
	%	80.3		1.0	5.7	10.8		2.2			81.3	16.5	2.2	88.2	10.8	1.0	
40-44	N	421		3	73	20	2	10			424	95	10	504	20	5	529
	%	79.6		.6	13.8	3.8	.4	1.9			80.2	18.0	1.9	95.3	3.8	.9	
45-49	N	467		2	60	19	1	13			469	80	13	540	19	3	562
	%	83.1		.4	10.7	3.4	.2	2.3			83.5	14.2	2.3	96.1	3.4	.5	
50-54	N	236		4	36	8	1	9			240	45	9	281	8	5	294
	%	80.3		1.4	12.2	2.7	.3	3.1			81.6	15.3	3.1	95.6	2.7	1.7	
55-59	N	208			34	7		5	1		208	41	6	247	8		255
	%	81.6			13.3	2.7		2.0	.4		81.6	16.1	2.4	96.9	3.1		
60-64	N	134		2	36	3		9			136	39	9	179	3	2	184
	%	72.8		1.1	19.6	1.6		4.9			73.9	21.2	4.9	97.3	1.6	1.1	
65-69	N	102		2	24			9			104	24	9	135		2	137
	%	74.5		1.5	17.5			6.6			75.9	17.5	6.6	98.5		1.5	
70 & OVER	N	34			6			2			34	6	2	42			42
	%	81.0			14.3			4.8			81.0	14.3	4.8	100.0			
TOTAL KNOWN	N	2886	1	27	332	205	5	91	3	2	2914	542	96	3309	209	34	3552
	%	81.3		.8	9.3	5.8	.1	2.6	.1	.1	82.0	15.3	2.7	93.2	5.9	1.0	
NO RESPONSE	N	5									5			5			5
	%	100.0									100.0			100.0			
	MD AGE	41.6	37.0	50.1	47.0	5[illegible].9	43.3	45.1	32.0	29.5	41.4	47.6	44.5	42.2	35.0	30.3	41.6

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0713 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-012 PHD
DIMENSION-003 EMP SPEC: ALL PANEL GROUPS

AGE		U.S. BIRTH			NONUS BIRTH			N.R. BIRTH			ALL	ALL	ALL	ALL	ALL	ALL	GRAND
		U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	N.R. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	TOTAL
UNDER 20	N																
	%																
20-24	N	1				4					1	4		1	4		5
	%	20.0				80.0					20.0	80.0		20.0	80.0		
25-29	N	1536		26	64	218	5	40	1	6	1562	287	47	1640	219	37	1896
	%	81.0		1.4	3.4	11.5	.3	2.1	.1	.3	82.4	15.1	2.5	86.5	11.6	2.0	
30-34	N	3498	1	38	204	687	16	83	4	6	3537	907	93	3785	692	60	4537
	%	77.1		.8	4.5	15.1	.4	1.8	.1	.1	78.0	20.0	2.0	83.4	15.3	1.3	
35-39	N	2290	1	17	275	530	15	88	3	1	2308	820	92	2653	534	33	3220
	%	71.1		.5	8.5	16.5	.5	2.7	.1		71.7	25.5	2.9	82.4	16.6	1.0	
40-44	N	1789	2	14	367	286	4	57	1	1	1805	657	59	2213	289	19	2521
	%	71.0	.1	.6	14.6	11.3	.2	2.3			71.6	26.1	2.3	87.8	11.5	.8	
45-49	N	1486	1	15	313	107	11	41	1		1502	431	42	1840	109	26	1975
	%	75.2	.1	.8	15.8	5.4	.6	2.1	.1		76.1	21.8	2.1	93.2	5.5	1.3	
50-54	N	730		5	159	41	3	44			735	203	44	933	41	8	982
	%	74.3		.5	16.2	4.2	.3	4.5			74.8	20.7	4.5	95.0	4.2	.8	
55-59	N	483		6	126	15		15	1	1	489	141	17	624	16	7	647
	%	74.7		.9	19.5	2.3		2.3	.2	.2	75.6	21.8	2.6	96.4	2.5	1.1	
60-64	N	305		3	103	10		13			308	113	13	421	10	3	434
	%	70.3		.7	23.7	2.3		3.0			71.0	26.0	3.0	97.0	2.3	.7	
65-69	N	202		2	71	2	1	18			204	74	18	291	2	3	296
	%	68.2		.7	24.0	.7	.3	6.1			68.9	25.0	6.1	98.3	.7	1.0	
70 + OVER	N	69			22	3	1	4			69	26	4	95	3	1	99
	%	69.7			22.2	3.0	1.0	4.0			69.7	26.3	4.0	96.0	3.0	1.0	
TOTAL KNOWN	N	12389	5	126	1704	1903	56	403	11	15	12520	3663	429	14496	1919	197	16612
	%	74.6		.8	10.3	11.5	.3	2.4	.1	.1	75.4	22.1	2.6	87.3	11.6	1.2	
NO RESPONSE	N	12		1	3	1	1	1			13	5	1	16	1	2	19
	%	63.2		5.3	15.8	5.3	5.3	5.3			68.4	26.3	5.3	84.2	5.3	10.5	
	VP 50=	37.0	40.0	34.4	43.7	34.9	36.0	39.0	33.3	30.0	37.0	38.4	38.5	37.9	34.9	36.7	37.4

#713 CITIZENSHIP AND COUNTRY OF BIRTH BY AGE,EMPLOYMENT SPECIALTY,DEGREE
DIMENSION-001 01
DIMENSION-002 NO PHD
DIMENSION-003 EMP SPEC: ALL PANEL GROUPS

		U.S. BIRTH -----			NONUS BIRTH -----			N.R. BIRTH -----			ALL	ALL	ALL	ALL	ALL	ALL	
AGE		U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. CITIZ	NON-CITIZ	CITIZ UNK	U.S. BIRTH	NONUS BIRTH	N.R. BIRTH	U.S. CITIZ	NONUS CITIZ	UNK. CITIZ	GRAND TOTAL
UNDER 20	N					1						1			1		1
	%					100.0						100.0			100.0		
20-24	N	828	1	24	38	104	3	31		2	857	145	33	897	105	33	1035
	%	80.0	.1	2.7	3.7	10.0	.3	3.0		.2	82.8	14.0	3.2	86.7	10.1	3.2	
25-29	N	5394	2	150	169	613	21	181	1	13	5546	803	195	5744	616	184	6544
	%	82.4		2.3	2.6	9.4	.3	2.8		.2	84.7	12.3	3.0	87.8	9.4	2.8	
30-34	N	3553	1	59	153	328	15	100	2	4	3613	496	106	3806	331	78	4215
	%	84.3		1.4	3.6	7.8	.4	2.4		.1	85.7	11.8	2.5	90.3	7.9	1.9	
35-39	N	2165	2	43	113	110	4	66	2	4	2210	227	72	2344	114	51	2509
	%	86.3	.1	1.7	4.5	4.4	.2	2.6	.1	.2	88.1	9.0	2.9	93.4	4.5	2.0	
40-44	N	1567		21	111	40	2	52		3	1588	153	55	1730	40	26	1796
	%	87.2		1.2	6.2	2.2	.1	2.9		.2	88.4	8.5	3.1	96.3	2.2	1.4	
45-49	N	1378	1	29	99	21	4	41		2	1408	124	43	1518	22	35	1575
	%	87.5	.1	1.8	6.3	1.3	.3	2.6		.1	89.4	7.9	2.7	96.4	1.4	2.2	
50-54	N	776		16	60	9		31	1	3	792	69	35	867	10	19	896
	%	86.6		1.8	6.7	1.0		3.5	.1	.3	88.4	7.7	3.9	96.8	1.1	2.1	
55-59	N	480		14	46	5		20			494	51	20	546	5	14	565
	%	85.0		2.5	8.1	.9		3.5			87.4	9.0	3.5	96.6	.9	2.5	
60-64	N	306		6	21	1	2	10		1	312	24	11	337	1	9	347
	%	88.2		1.7	6.1	.3	.6	2.9		.3	89.9	6.9	3.2	97.1	.3	2.6	
65-69	N	132		2	11	4		5		1	134	15	6	148	4	3	155
	%	85.2		1.3	7.1	2.6		3.2		.6	86.5	9.7	3.9	95.5	2.6	1.9	
70 + OVER	N	19			2			2			19	2	2	23			23
	%	82.6			8.7			8.7			82.6	8.7	8.7	100.0			
TOTAL KNOWN	N	16598	7	368	823	1236	51	539	6	33	16973	2110	578	17960	1249	452	19661
	%	84.4		1.9	4.2	6.3	.3	2.7		.2	86.3	10.7	2.9	91.3	6.4	2.3	
NO RESPONSE	N	32		2		5	1	2		2	34	6	4	34	5	5	44
	%	72.7		4.5		11.4	2.3	4.5		4.5	77.3	13.6	9.1	77.3	11.4	11.4	
	MP 50%	32.4	32.0	30.0	36.0	28.7	30.0	32.4	34.5	31.4	32.4	30.6	32.4	32.0	28.7	30.1	32.2

A127

*T15 ADDITIONAL EMPLOYER BY EMPLOYER, EMPLOYMENT SPECIALTY, DEGREE
PHD OR NOT - PHD
EMP SPEC - TOTAL

		ADDITIONAL EMPLOYER						
TYPE OF EMPLOYER		COLL UNIV	PRIV IND	GOV'T	RES CTR	OTHER	N.R.	TOTAL
COLLEGE OR UNIV	N	3	71	92	17	63	8017	8263
	%		.9	.4	.2	.8	97.5	100.0
PRIVATE INDUSTRY	N	55	4	1	2	17	3726	3805
	%	1.4	.1		.1	.4	97.9	99.9
GOV'T - FEDERAL ETC	N	39	1			14	1414	1468
	%	2.7	.1			1.0	96.3	100.1
RESEARCH CENTER	N	37	4	2		9	1860	1912
	%	1.9	.2	.1		.5	97.3	100.0
OTHER KNOWN	N	16	8	7	1	13	793	840
	%	1.9	1.0	.8	.1	1.6	94.4	100.0
NO RESPONSE	N						303	303
	%						100.0	100.0
TOTAL	N	150	88	62	20	116	14193	14629
	%	.9	.5	.4	.1	.7	97.4	100.0

A128

PHD OR NOT - NO PHD
EMP SPEC - TOTAL

		ADDITIONAL EMPLOYER						
COLLEGE OR UNIV	N	5	22	9	4	30	5240	5310
	%	.1	.4	.2	.1	.6	98.7	100.1
PRIVATE INDUSTRY	N	41	3	2		31	5269	5346
	%	.8	.1			.6	98.6	100.1
GOV'T - FEDERAL ETC	N	16	5	1	1	13	2509	2545
	%	.6	.2			.5	98.6	99.9
RESEARCH CENTER	N	8	3		1	7	858	877
	%	.9	.3		.1	.8	97.8	99.9
OTHER KNOWN	N	52	23	24	2	52	3449	3602
	%	1.4	.6	.7	.1	1.4	95.8	100.0
NO RESPONSE	N						2026	2026
	%						100.0	100.0
TOTAL	N	121	56	36	8	133	19351	19705
	%	.6	.3	.2		.7	98.2	100.0

PHD OR NOT - PHD
TYPE OF EMPLOYER - COLLEGE OR UNIVERSITY
PRIMARY ACTIVITY - TOTAL

A129

		EMP SPEC																		
THEORETICAL	N	85	142	393	185	97	68	165	346	55	11	30	11	69	9	10	2	6	453	1972
	H	4.3	7.2	19.9	9.4	4.9	3.4	8.4	17.5	2.8	.6	1.5	.6	3.5	.5	.5	.1	.3	23.0	
	V	46.4	24.7	36.8	19.9	35.1	27.3	31.4	19.3	20.2	8.7	10.3	11.1	29.1	40.9	23.8	5.3	18.8	22.8	24.0
EXPERIMENTAL	N	42	227	426	470	46	72	118	816	88	38	108	32	76		8	22	10	713	3194
	H	1.3	7.1	13.3	14.7	1.4	2.3	3.7	25.5	2.8	1.2	3.4	1.0	2.4		.3	.7	.3	22.3	
	V	23.0	39.4	39.9	50.6	16.7	28.9	22.5	45.6	32.4	29.9	37.0	32.3	32.1		19.0	57.9	31.3	35.8	38.8
BOTH	N	25	98	63	88	85	58	143	272	73	48	100	34	60	8	18	7	8	367	1413
	H	1.8	6.9	4.5	6.2	6.0	4.1	10.1	19.3	5.2	3.4	7.1	2.4	4.2	.6	1.3	.5	.6	26.0	
	V	13.7	17.0	5.9	9.5	30.8	23.3	27.2	15.2	26.8	37.8	34.2	34.3	25.3	36.4	42.9	18.4	25.0	18.5	17.2
NO RESP	N	31	109	187	186	48	51	99	357	56	30	54	22	32	5	6	7	8	456	1643
	H	1.9	6.6	11.4	11.3	2.9	3.1	6.0	21.7	3.4	1.8	3.3	1.3	1.9	.3	.4	.4	.5	27.7	
	V	16.9	18.9	17.5	20.0	17.4	20.5	18.9	19.9	20.6	23.6	18.5	22.2	13.5	22.7	14.3	18.4	25.0	22.9	20.0
TOTAL	N	183	576	1069	929	276	249	525	1791	272	127	292	99	237	22	42	38	32	1989	8223
	H	2.2	7.0	13.0	11.3	3.4	3.0	6.4	21.8	3.3	1.5	3.6	1.2	2.9	.3	.5	.5	.4	24.2	
	V	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.1	100.0	100.0

PHD OR NOT - PHD
TYPE OF EMPLOYER - PRIVATE INDUSTRY
PRIMARY ACTIVITY - TOTAL

A130

		EMP SPEC																		
THEORETICAL	N	3	18	5	20	36	19	55	122	32	1	45	25	1	7	2		2	140	478
	H	.6	3.8	1.0	4.2	7.5	4.0	11.5	25.5	6.7	.2	9.4	5.2	.2	1.5	.4		.4	29.3	
	V	16.7	7.4	16.7	11.6	23.7	26.4	24.6	8.3	19.6	3.3	8.4	18.9	25.0	50.0	18.2		25.0	19.0	12.6
EXPERIMENTAL	N	6	110	15	88	33	13	46	768	50	13	207	25			4	5	6	199	1542
	H	.4	7.1	1.0	5.7	2.1	.8	3.0	49.8	3.2	.8	13.4	1.6			.3	.3	.4	12.9	
	V	33.3	45.3	50.0	51.2	21.7	18.1	20.5	52.1	30.7	43.3	38.6	18.9			36.4	50.0	75.0	27.0	40.5
BOTH	N	2	65	4	34	53	19	72	325	47	8	182	54	1	1	3	3		205	1006
	H	.2	6.5	.4	3.4	5.3	1.9	7.2	32.3	4.7	.8	18.1	5.4	.1	.1	.3	.3		20.4	
	V	11.1	26.7	13.3	19.8	34.9	26.4	32.1	22.1	28.8	26.7	34.0	40.9	25.0	7.1	27.3	30.0		27.9	26.4
NO RESP	N	7	49	6	30	30	21	51	258	34	8	104	28	2	6	2	2		192	779
	H	.9	6.3	.8	3.9	3.9	2.7	6.5	33.1	4.4	1.0	13.4	3.6	.3	.8	.3	.3		24.6	
	V	38.9	20.2	20.0	17.4	19.7	29.2	22.8	17.5	20.9	26.7	19.4	21.2	50.0	42.9	18.2	20.0		26.1	20.5
TOTAL	N	18	243	30	172	152	72	224	1473	163	30	536	132	4	14	11	10	8	736	3805
	H	.5	6.4	.8	4.5	4.0	1.9	5.9	38.7	4.3	.8	14.1	3.5	.1	.4	.3	.3	.2	19.3	
	V	100.0	100.0	100.0	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0	99.9	100.0	100.0	100.1	100.0	100.0	100.0	100.0

PHD OR NOT - PHD
TYPE OF EMPLOYER - GOV'T - FEDERAL ETC
PRIMARY ACTIVITY - TOTAL

A131

		EMP SPEC																		
THEORETICAL	N	9	19	10	17	13	16	29	51	32		6	11	7	5	2		9	41	247
	H	3.6	7.7	4.0	6.9	5.3	6.5	11.7	20.6	13.0		2.4	4.5	2.8	2.0	.8		3.6	16.6	
	V	39.1	18.8	22.7	15.3	25.0	30.8	27.9	13.1	20.8		5.5	18.0	16.7	31.3	10.0		36.0	17.7	16.9
EXPERIMENTAL	N	5	47	22	50	11	14	25	189	43	13	51	14	17	1	4	9	7	64	561
	H	.9	8.4	3.9	8.9	2.0	2.5	4.5	33.7	7.7	2.3	9.1	2.5	3.0	.2	.7	1.6	1.2	11.4	
	V	21.7	46.5	50.0	45.0	21.2	26.9	24.0	48.5	27.9	50.0	46.8	23.0	40.5	6.3	20.0	81.8	28.0	27.7	38.4
BOTH	N	5	15	4	17	19	13	32	70	45	8	25	22	9	7	11	2	5	61	336
	H	1.5	4.4	1.2	5.0	5.6	3.8	9.5	20.7	13.3	2.4	7.4	6.5	2.7	2.1	3.3	.6	1.5	18.0	
	V	21.7	14.9	9.1	15.3	36.5	25.0	30.8	17.9	29.2	30.8	22.9	36.1	21.4	43.8	55.0	18.2	20.0	26.4	23.0
NO RESP	N	4	20	8	27	9	9	18	80	34	5	27	14	9	3	3		4	65	321
	H	1.2	6.2	2.5	8.4	2.8	2.8	5.6	24.9	10.6	1.6	8.4	4.4	2.8	.9	.9		1.2	20.2	
	V	17.4	19.8	18.2	24.3	17.3	17.3	17.3	20.5	22.1	19.2	24.8	23.0	21.4	18.8	15.0		16.0	28.1	22.0
TOTAL	N	23	101	44	111	52	52	104	390	154	26	109	61	42	16	20	11	25	231	1460
	H	1.6	6.9	3.0	7.6	3.5	3.5	7.1	26.7	10.5	1.8	7.4	4.2	2.9	1.1	1.4	.7	1.7	15.7	
	V	99.9	100.0	100.0	99.9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.1	100.0	100.0	100.0	100.0	100.0	99.9	100.0

PHD OR NOT - PHD
TYPE OF EMPLOYER - RESEARCH CENTER
PRIMARY ACTIVITY - TOTAL

A132

		EMP SPEC																		
THEORETICAL	N	3	22	28	71	32	34	66	65	23	2	12	1	2	2	2		5	54	358
	H	.8	6.1	7.8	19.8	8.9	9.5	18.4	18.2	6.4	.6	3.4	.3	.6	.6	.6		1.4	15.1	
	V	13.6	21.4	12.0	16.2	42.7	24.3	30.7	17.3	24.0	8.3	14.0	6.3	13.3	22.2	18.2		25.0	23.1	18.7
EXPERIMENTAL	N	12	46	141	215	16	44	60	178	34	11	42	6	6	2	3	9	7	71	847
	H	1.4	5.4	16.7	25.4	1.9	5.2	7.1	21.0	4.0	1.3	5.0	.7	.7	.2	.4	1.1	.8	8.4	
	V	54.5	44.7	60.5	49.1	21.3	31.4	27.9	47.3	35.4	45.8	48.8	37.5	40.0	22.2	27.3	64.3	35.0	30.3	44.3
BOTH	N	5	12	17	64	12	28	40	65	17	8	17	5	5	1	3	3	4	52	318
	H	1.6	3.8	5.3	20.1	3.8	8.8	12.6	20.4	5.3	2.5	5.3	1.6	1.6	.3	.9	.9	1.3	16.4	
	V	22.7	11.7	7.3	14.6	16.0	20.0	18.6	17.3	17.7	33.3	19.8	31.3	33.3	11.1	27.3	21.4	20.0	22.2	16.6
NO RESP	N	2	23	47	88	15	34	49	69	22	3	15	4	2	4	3	3	4	57	394
	H	.5	5.8	11.9	22.3	3.8	8.6	12.4	17.5	5.6	.8	3.8	1.0	.5	1.0	.8	.8	1.0	14.5	
	V	9.1	22.3	20.2	20.1	20.0	24.3	22.8	18.4	22.9	12.5	17.4	25.0	13.3	44.4	27.3	21.4	20.0	24.4	20.6
TOTAL	N	22	103	233	438	75	140	215	376	96	24	86	16	15	9	11	14	20	234	1912
	H	1.2	5.4	12.2	22.9	3.9	7.3	11.2	19.7	5.0	1.3	4.5	.8	.8	.5	.6	.7	1.0	12.2	
	V	99.9	100.1	100.0	100.0	100.0	100.0	100.0	100.1	100.0	99.9	100.0	100.1	99.9	99.9	100.1	100.0	100.0	100.0	99.9

PHD CR NOT - PHD
TYPE OF EMPLOYER - OTHER KNOWN
PRIMARY ACTIVITY - TOTAL

A133

EMP SPEC

THEORETICAL	N	4	8	13	14	3	4	7	21	2	8	4		3		1		1	40	126
	H	3.2	6.3	10.3	11.1	2.4	3.2	5.6	16.7	1.6	6.3	3.2		2.4		.8		.8	31.7	
	V	66.7	18.6	39.4	10.6	20.0	19.0	19.4	16.5	7.4	11.9	7.5		21.4		11.1		16.7	15.0	15.0
EXPERIMENTAL	N		19	12	64	2	6	8	47	10	22	17	6	7		5	1	2	62	282
	H		6.7	4.3	22.7	.7	2.1	2.8	16.7	3.5	7.8	6.0	2.1	2.5		1.8	.4	.7	22.0	
	V		44.2	36.4	48.5	13.3	28.6	22.2	37.0	37.0	32.8	32.1	37.5	50.0		55.6	25.0	33.3	23.2	33.6
BOTH	N	1	10	4	34	8	6	14	34	8	21	14	4	1			1	2	69	216
	H	.5	4.6	1.9	15.7	3.7	2.8	6.5	15.7	3.7	9.7	6.5	1.9	.5			.5	.9	31.9	
	V	16.7	23.3	12.1	25.8	53.3	28.6	38.9	26.8	29.6	31.3	26.4	25.0	7.1			25.0	33.3	25.8	25.7
NO RESP	N	1	6	4	20	2	5	7	25	7	16	18	6	3		3	2	1	97	216
	H	.5	2.8	1.9	9.3	.9	2.3	3.2	11.6	3.2	7.4	8.3	2.8	1.4		1.4	.9	.5	44.9	
	V	16.7	14.0	12.1	15.2	13.3	23.8	19.4	19.7	25.9	23.9	34.0	37.5	21.4		33.3	50.0	16.7	36.3	25.7
TOTAL	N	6	43	33	132	15	21	36	127	27	67	53	16	14		9	4	6	267	840
	H	.7	5.1	3.9	15.7	1.8	2.5	4.3	15.1	3.2	8.0	6.3	1.9	1.7		1.1	.5	.7	31.8	
	V	100.1	100.1	100.0	100.1	99.9	100.0	99.9	100.0	99.9	99.9	100.0	100.0	99.9		100.0	100.0	100.0	100.0	100.0

PHD OR NOT - PHD
TYPE OF EMPLOYER - TOTAL KNOWN
PRIMARY ACTIVITY - TOTAL

A134

EMP SPEC

THEORETICAL	N	104	209	449	307	181	141	322	605	144	22	97	48	82	23	17	2	23	720	3182
	H	3.3	6.6	14.1	9.6	5.7	4.4	10.1	19.0	4.5	.7	3.0	1.5	2.6	.7	.5	.1	.7	22.6	
	V	41.3	19.6	31.9	17.2	31.8	26.4	29.2	14.6	20.2	8.0	9.0	14.8	26.3	37.7	18.3	2.6	25.3	21.1	19.6
EXPERIMENTAL	N	65	449	616	887	108	149	257	1907	225	97	425	83	106	3	24	46	32	1109	6421
	H	1.0	7.0	9.6	13.8	1.7	2.3	4.0	31.1	3.5	1.5	6.6	1.3	1.7		.4	.7	.5	17.3	
	V	25.8	42.2	43.7	49.8	18.9	27.9	23.3	46.0	31.6	35.4	39.4	25.6	34.0	4.9	25.8	59.7	35.2	32.1	39.5
BOTH	N	38	200	92	237	177	124	301	766	190	93	330	119	76	17	35	16	19	751	3290
	H	1.2	6.1	2.8	7.2	5.4	3.8	9.1	23.3	5.8	2.8	10.1	3.6	2.3	.5	1.1	.5	.6	22.9	
	V	15.1	18.8	6.5	13.3	31.1	23.2	27.3	18.4	26.7	33.9	31.4	36.7	24.4	27.9	37.6	20.8	20.9	21.8	20.2
NO RESP	N	45	207	252	351	104	120	224	789	153	62	218	74	48	18	17	13	17	867	3159
	H	1.3	6.2	7.5	10.5	3.1	3.6	6.7	23.5	4.6	1.8	6.5	2.2	1.4	.5	.5	.4	.5	25.8	
	V	17.9	19.4	17.9	19.7	18.2	22.5	20.3	19.0	21.5	22.6	20.2	22.8	15.4	29.5	18.3	16.9	18.7	25.1	20.6
TOTAL	N	252	1063	1409	1782	570	534	1104	4157	712	274	1070	324	312	61	93	77	91	3457	16240
	H	1.6	6.6	8.7	11.0	3.5	3.3	6.8	25.6	4.4	1.7	6.6	2.0	1.9	.4	.6	.5	.6	21.3	
	V	100.1	100.0	100.0	100.0	100.0	100.0	100.1	100.0	100.0	99.9	100.0	99.9	100.1	100.0	100.0	100.0	100.1	100.1	99.9

APPENDIX B: ALLOCATION OF NATIONAL REGISTER SPECIALTIES TO PHYSICS SUBFIELDS

		PhD's	Non-PhD's
PP 1	A&R		
5823	Gravitational fields, gravitons	26	8
6014	Cosmology	16	8
6015	Galaxies	45	17
6018	Quasars, pulsars, x-ray sources	84	40
6035	Relativity, gravitation	77	35
PP 2	AME		
5673	Chemical kinetics, gas phase, and photochemistry	26	18
5684	Flames and explosives	8	32
5693	Molecular spectroscopy	101	51
5694	Molecular structure	26	17
5696	Quantum and valence theory	22	9
5791	Atomic and molecular ions	51	38
5792	Atomic, molecular, and electron beams	106	66
5793	Atoms with $Z > 2$	47	17
5794	Collision processes	208	93
5795	Free radicals	6	7
5796	Hydrogen and helium atoms	22	30
5797	Inorganic molecules	3	9
5798	Macromolecules and polymers	69	24
5801	Mesic and muonic atoms and molecules	11	7
5802	Organic molecules	8	10
5809	Other (atoms and molecules)	52	28
5942	Kinetic theory	14	4
Overlap Group			
5861	Quantum mechanics (1/2)	29	7
5986	NMR-EPR instrumentation (1/4)	5	4
	Spectroscopy (1/2)		
5678	Electronic spectroscopy including far uv	7	6
5891	Spectroscopy	71	75
5998	Spectroscopes	5	12
	X rays (1/5)		
5818	X rays and gamma rays	12	15
6004	X-ray instrumentation	8	13
	Modern optics (1/4)		
5698	Scattering phenomena	3	3
5814	Interaction of electromagnetic waves with matter	27	19
5884	Lasers	82	71
5885	Nonlinear optics	20	10
5983	Lasers and masers	6	10

			PhD's	Non-PhD's
PP 3	EP			
	5821	Cosmic rays	99	41
	5822	Electromagnetic fields, photons	94	48
	5824	Hadrons	741	312
	5825	Leptons	94	42
	5826	Quantum field theory	129	73
	5829	Other (elementary-particles and fields)	111	66
	Overlap Group			
	5861	Quantum mechanics (1/4)	14	3
		Beams (1/2)		
	5973	Beam handling	8	6
	5988	Particle accelerators	63	40
	5991	Particle and beam sources	5	5
	5992	Particle detectors	21	26
PP 4	NP			
	5695	Nuclear and radio chemistry	6	13
	5697	Radiation and hot-atom chemistry	5	7
	5871	Nuclear decay and radio activity	132	84
	5872	Nuclear reactions and scattering	593	279
	5873	Nuclear structure and energy levels	400	198
	5879	Other (nuclei)	220	186
	5966	Health and medical physics	162	336
	5987	Nuclear Reactors	128	138
	Overlap Group			
		X rays (1/5)		
	5818	X rays and gamma rays	12	15
	6004	X-ray instrumentation	8	13
		Beams (1/2)		
	5973	Beam handling	8	6
	5988	Particle accelerators	63	40
	5991	Particle and beam sources	5	5
	5992	Particle detectors	21	26

			PhD's	Non-PhD's
PP 5	P&F			
	5831	Dispersions and colloids	8	2
	5832	Electric discharges	51	37
	5833	Fluid mechanics	257	145
	5834	Gases	20	13
	5835	Ionization	1	5
	5836	Liquids	23	21
	5849	Other (fluids)	24	38
	5853	Continuum	63	24
	5937	Magnetofluid dynamics	28	11
	5838	Plasmas	488	211
	5994	Plasma containment	8	12
	Overlap Group			
		Thermal (3/10)		
	5682	Equilibrium and thermodynamic relationships	2	1
	5941	High-temperature physics	8	4
	5944	Phase transitions and changes of state	14	9
	5945	Statistical mechanics	20	8
	5946	Thermal measurement techniques	5	7
	5947	Thermal properties	4	6
	5948	Thermodynamics	5	9
	5951	Transport phenomena	14	8
	5959	Other (thermal physics)	6	5
	5981	High temperature instrumentation	0	2
	6002	Thermometric instrumentation	0	3
	5775	Shock waves (4/5)	28	38
PP 6	CM			
	5671	Catalysis	5	2
	5674	Chemical kinetics, liquid phase	4	1
	5676	Crystallography	48	38
	5692	Liquid state and solutions; electrolytes and nonelectrolytes	10	6
	5701	Solid state chemistry	23	9
	5815	Magnetism	33	41
	5841	Quantum fluids	53	22
	5856	Many-body theory	31	14
	5858	Plasticity	7	3
	5862	Statistical mechanics	52	11
	5902	Alloys	54	29
	5903	Crystal growth	43	31
	5904	Crystal structure	30	29

PP 6 CM

		PhD's	Non-PhD's
5905	Dendrites and composites	6	3
5906	Dielectrics	41	33
5907	Diffusion in solids	46	17
5908	Electron states	139	55
5911	Electron transport and carrier properties	156	87
5912	Imperfections	105	42
5914	Lattice mechanics	60	34
5915	Luminescence	66	41
5916	Magnetic properties	242	125
5917	Magnetic resonance	258	126
5918	Mechanical properties	89	50
5921	Metallic conductors	29	17
5922	Mössbauer effect	74	36
5923	Noncrystalline states	34	17
5924	Optical properties	218	110
5925	Semiconductors	305	254
5926	Solid-state devices	311	237
5927	Superconductors	174	91
5928	Surfaces, interfaces, films	260	232
5931	Thermal properties of solids	33	39
5939	Other (solids)	145	135
5943	Low-temperature physics	158	92
5978	High-pressure instrumentation	8	10
5982	Information storage	20	27
5997	Semiconductors	10	28
Overlap Group			
	Mechanics (1/4)		
5861	Quantum mechanics	14	3
	NMR & EPR (3/4)		
5986	NMR-EPR instrumentation	15	14
	Mechanical (1/2)		
5854	Elasticity	10	5
5855	Friction	1	4
6003	Vacuum	11	38
	Ultrasound (2/3)		
3777	Ultrasonics	51	52
5901	Acoustic properties	20	10
	X rays (3/5)		
5818	X rays and gamma rays	36	45
6004	X-ray instrumentation	24	39
	Measurement and instruments (1/2)		
5811	Electrical quantities and their measurement	10	26

				PhD's	Non-PhD's
PP	6	CM			
		Overlap Group			
		5857	Measurement of mechanical properties	13	23
		5913	Interaction of radiation with solids	94	64
		5976	Electronics	51	160
		6009	Other (instrumentation)	41	108
		6037	Units, constants, standards, conversion factors	2	6
			Shock waves (1/5)		
		5775	Shock waves	7	9
			Thermal (7/10)		
		5682	Equilibrium and thermodynamic relationships	4	3
		5941	High-temperature physics	19	8
		5944	Phase transitions, changes of state	33	20
		5945	Statistical mechanics	47	18
		5946	Thermal measurement techniques	11	16
		5947	Thermal properties	10	15
		5948	Thermodynamics	12	20
		5951	Transport phenomena	33	19
		5959	Other (thermal physics)	13	12
		5981	High-temperature instrumentation	1	4
		6002	Thermometric instrumentation	1	6
			Modern optics (1/4)		
		5698	Scattering phenomena	3	4
		5814	Interaction of electromagnetic waves with matter	27	19
		5884	Lasers	20	10
		5885	Nonlinear optics	20	10
		5983	Lasers and masers	6	10
PP	7	E&P			
		4991	Aeronomy	24	27
		4992	Air-sea interaction	1	4
		4993	Atmospheric chemistry and radioactivity	11	7
		4994	Atmospheric dynamics, thermodynamics	7	17
		4995	Atmospheric electricity	6	9
		4997	Aurora, airglow	9	20
		4998	Cloud and precipitation physics	16	15

		PhD's	Non-PhD's
PP 7 E&P			
5001	Cosmic rays	6	4
5002	Ionosphere	28	34
5003	Mesometeorology	1	5
5004	Micrometeorology	0	5
5005	Numerical modeling	13	9
5006	Planetary atmospheres	14	8
5007	Radiative transfer	31	21
5008	Turbulence and diffusion	12	10
5009	Other (atmospheric structure and dynamics)	18	17
5028	Rocket meteorology	0	0
5031	Satellite meteorology	0	0
5161	Exploration, gravity	2	5
5162	Exploration, magnetic	5	3
5163	Exploration, seismology	24	23
5164	Geomagnetism and paleomagnetism	5	12
5165	Gravity	3	8
5166	Heat flow	1	1
5167	Physical properties of natural materials	16	9
5168	Seismology	12	24
5171	Tectonics	1	0
5172	Volcanology	0	0
5179	Other (solid-earth geophysics)	21	8
5185	Physical oceanography	11	14
5191	Underwater sound	0	0
5199	Other (oceanography)	10	14
5302	Lunar and planetary geology	7	10
5331	Aeronomy	23	12
5332	Aurora and airglow	23	16
5333	Cosmic rays	11	30
5334	Geomagnetic pulsations	7	3
5335	Interplanetary particles and fields	26	14
5336	Ionosphere	17	20
5337	Magnetospheric particles and waves	78	50
5350	Atmospheric sciences	33	46
5360	Earth sciences	24	39
Overlap Group			
	Solar/planetary (1/2)		
5338	Solar and planetary physics	26	20
5341	Solar wind	11	5
5349	Other (solar/planetary)	6	5
6023	Sun	46	21
4996	Atmospheric optics and acoustics (1/2)	15	12

			PhD's	Non-PhD's
PP 8	PB			
	5688	Ion exchange and membrane phenomena	3	4
	5962	Bioelectricity	21	12
	5963	Bioenergetics	8	8
	5964	Biological molecules	86	27
	5969	Other (biophysics)	89	49
	6580	Biological and biomedical sciences	44	34
	Overlap Group			
		Hearing (2/5)		
	5772	Hearing	6	6
	5776	Speech	7	4
	5961	Bioacoustics	3	2
		Bio-optics (1/3)		
	5892	Vision	3	2
	5965	Bio-optics	2	2
PP 9	Optics			
	5813	Infrared, visible, and uv radiation	42	142
	5881	Colorimetry	7	16
	5882	Geometric optics	31	208
	5883	Holography	74	94
	5886	Photography	24	114
	5887	Photometry, radiometry, and illumination	39	209
	5888	Physics optics	98	144
	5899	Other (optics)	104	286
	5985	Microscopes	6	19
	5993	Photographic instrumentation	7	43
	Overlap Group			
		Measurement and instruments (1/2)		
	5811	Electrical quantities and their measurement	10	26
	5857	Measurement of mechanical properties	13	23
	5913	Interaction of radiation with solids	94	64
	5976	Electronics	51	160
	6009	Other (instrumentation)	41	108
	6037	Units, constants, standards, conversion factors	2	6
		Spectroscopy (1/2)		

				PhD's	Non-PhD's
PP	9		Optics		
			Overlap Group		
		5678	Electronic spectroscopy including far uv	7	6
		5891	Spectroscopy	71	75
		5998	Spectroscopes	5	12
			Bio-optics (2/3)		
		5892	Vision	7	5
		5965	Bio-optics	6	4
			Modern optics (1/2)		
		5698	Scattering phenomena	6	7
		5814	Interaction of electromagnetic waves with matter	55	38
		5884	Lasers	163	141
		5885	Nonlinear optics	41	20
		5983	Lasers and masers	12	21
		5996	Atmospheric optics and acoustics (1/2)	15	12
PP	10		Acoustics		
		5771	Architectural acoustics	10	35
		5773	Music	8	7
		5774	Noise	33	120
		5778	Underwater sound	155	407
		5781	Vibrations	21	55
		5789	Other (acoustics)	33	57
			Overlap Group		
			Ultrasound (1/3)		
		5777	Ultrasonics	26	26
		5901	Acoustic properties	10	5
			Hearing (3/5)		
		5772	Hearing	9	9
		5776	Speech	9	6
		5961	Bioacoustics	5	3
PP	11		Astrophysics		
		6011	Binary stars	23	19
		6012	Clusters	14	1
		6016	Interstellar medium	66	32
		6021	Stellar composition	32	29
		6022	Stellar evolution	50	22
		6029	Other	129	85
P	12		Astronomy		
		5852	Celestial mechanics	61	69

			PhD's	Non-PhD's
PP 13	Interplanetary			
	5301	Interplanetary matter	9	2
	5304	Meteorites and tektites	5	1
	5305	Planetary atmospheres	30	11
	5306	Planetary magnetic fields	2	2
	5309	Other (planetology)	6	6
	6013	Comets, meteors, interplanetary medium	15	10
	6017	Planets and satellites	26	18
PP 14	Instrumentation			
	5972	Astronomical	32	29
	5996	Radio astronomy	39	17
	6001	Telescopes	5	14
PP 15	Overlap with E&P (1/2)			
	5338	Solar planetary physics	26	20
	5341	Solar wind	11	5
	5349	Other (solar/planetary)	6	5
	6023	Sun	46	21